

WALTER REED MONOGRAPH

OCCUPATIONAL THERAPY

APPLIED TO

RESTORATION OF FUNCTION

OF

DISABLED JOINTS

BY

BIRD T. BALDWIN, Major, S. C., U. S. A.

Director of Occupational Therapy and Chief Psychologist

Walter Reed General Hospital

Takoma Park, Washington, D. C.

WALTER REED MONOGRAPH

OCCUPATIONAL THERAPY

APPLIED TO

RESTORATION OF FUNCTION

OF

DISABLED JOINTS

BY

BIRD T. BALDWIN, Major, S. C., U. S. A.

Director of Occupational Therapy and Chief Psychologist

Walter Reed General Hospital

Takoma Park, Washington, D. C.

**Printed on the authority of the
Surgeon General of the Army**

Typed by the Occupational Therapy Department

APRIL 1919

OUTLINE OF CONTENTS.

- I. Introduction.
 - a. Purpose of Monograph.
 - b. Preliminary Case Study.
 - c. Formulation of Problem.—Plate 1.
- II. Explanation of Occupational Therapy.
- III. Procedure in Assigning Cases in Curative Work.—Plate 2.
- IV. Typical Assignments in Occupational Therapy (5 Cases).
Plate 3.
- V. Measurements of
 - a. Range of Voluntary Movement in Stiff Joints.—Plates 4-19. (Progress Curves, Tables 1-2).
 1. Individual Illustrations.
 2. Summary of Type Cases.
 - b. Strength of Voluntary Movement in Stiff Joints.
Plates 20-22. (Type Cases of Strength—3 Cases).
- VI. Examples of Types of Movements Occuring in Various Occupational Activities.—Plates 23-43.
- VII. Preliminary Type Studies of Movements Involved in
 - a. Planing.
 - b. Engraving.—Plates 44-45.
- VIII. Peripheral Nerve Palsies.
- IX. Partial List of Tools of Special Curative Value.—Plates 46-48.
- X. Type Cases of Occupational Therapy. (3 Cases).
- XI. Supplementary Comments.
- XII. Outline of Psychological Service in Hospital.

I Introduction

This monograph presents in a preliminary and suggestive form the aim, scope and methods of one phase of Occupational Therapy as worked out inductively in the Walter Reed General Hospital.

The aim of the monograph is to formulate a program in order that the problem may be further carried out in other hospitals and in order that we may receive suggestions and criticism for work in our laboratories and shops.

The writer was assigned to this hospital April 25, 1918, as Chief Psychologist, and the first case that he examined was that of Pvt. R. G. P., who was sent here with a disability of chronic osteo-arthritis of meta-phalangeal joints of the 2d, 3d and 4th fingers of the right hand, with cause unrecorded.

In addition to the clinical study of the patient's social, educational and vocational history, an intelligence rating and further psychological examinations were given him, with particular reference to motor coordinations. A detailed study which discussed the voluntary movement of the affected hand was submitted to the Surgeon General of the Army. A portion of the report read as follows:

Movements of Affected Part—Hand (Right). See X-Ray plate,



Right hand of Pvt. R. G. P.

1st Finger (thumb) apparently normal movement present.

2d Finger, 1st joint stiff, and cannot be flexed, good power and free movement otherwise.

3d Finger, constantly flexed, cannot be extended to a straight position. No movement in first joint; second joint limited movement, and third joint at hand, very little movement. No movement sideways. Painful when struck or when shaking hands. Cannot

EDUCATIONAL SERVICE
WALTER REED GENERAL HOSPITAL
TAKOMA PARK, D. C.

MEDICAL OFFICER'S PRESCRIPTION

(This prescription will be filed in the Surgeon General's Office as a part of the Physical Reconstruction Register.)

Name A. J. P., U. P.
Ward 5B Oct. 24, 1919
Diagnosis 63 H. Hand, Lt. FCC, metacarpal bones. Limitation finger motion.

Probable length of stay in hospital..... weeks

Result to be attained ultimately
Increased function fingers and wrist

In orthopedic cases needing curative work check below:

Thumb	}	Abduction	Toes
Finger		Adduction	Mid-Tarsus
Wrist		Flexion	Ankle
Elbow	}	Extension	Knee
Shoulder		Pronation	Hip
Back		Supination	
		Circumduction	

To be avoided.....
.....
.....
Remarks:

This man is ready for assignments checked below (please include all of which he is capable):

	Curative	Occupational Only	Hours
Ward Work— Mental Physical			
Classroom			
Shop or Farm	✓		

E. G. W.
Medical Officer's Signature.

Name: A. J. P., U. P.

Date: Oct. 30, 1919

Ward 5B

WALTER REED GENERAL HOSPITAL
TAKOMA PARK, D. C.

DIVISION OF RECONSTRUCTION
Building No. 93.

Time.	Subject.
8:00	
8:30	
9:00	
9:30	
10:00	Measurements of movements (Mon, Wed, Fri.)
10:30	
11:00	10.45 to 11.45 Engraving (Curative)*
11:30	
12:00	
1:15	
1:45	
2:15	Academic Studies
2:45	" "
3:15	" "
3:45	
4:15	
4:45	

Ward Work.—Time to be arranged with patient in

Remarks: * Flexion of fingers in grasping and using engraving tool with left hand. Pronation-supination in "wriggling." Extension of fingers, extension-flexion and abduction-adduction of wrist by holding plate with left hand and engraving with right. By alternating from right to left hand engraving, all the required movements are obtained without fatigue.

Assignment Office.

Plate 2

Medical Officer's Prescription and Assignment Program

bend halfway to palm and the hand hurts "like a wire catches." Limitation of motion in full extension.

4th Finger, flexed toward hand. No movement in first joint, little in third joint. If placed over second finger, cannot be removed voluntarily. Flexed to approximately 45 degrees.

5th Finger, only slightly flexed. Some movement in first joint, little more in second, and more in third. Binds over knuckles. From the standpoint of precision the movements of the arm were comparatively accurate and those of the fingers inaccurate and slow.

X-Ray photograph on file in Psychological Laboratory shows ankylosis and marked deposits at joints.

The subject was later placed under an anaesthetic and the fingers extended. A cast was worn for several weeks and a little improvement shown.

A careful study of this first case showed the possibility of a fertile and practical field in the measurement of the excursion and strength of voluntary movements in partially ankylosed joints, and indicated some of the opportunities for the application of occupational activities for remedial treatment.

Since the date of this first fortnightly report, the Department of Occupational Therapy has considered curative work as applied to stiff joints one of its problems. All Departments and lines of activities in the hospital bearing on this problem have been coordinated through the cooperation of the Psychological Service, the Curative Shops, the X-Ray Service and the Orthopedic and Medical Service.

We are now in a position to present to other hospitals a tentative program continued through several months of development and experiments. This outline of procedure is based on intensive individual studies with progress curves and clinical occupational notes.

II Explanation of Occupational Therapy

Occupational Therapy is based on the principle that the best type of remedial exercise is that which requires a series of specific voluntary movements involved in the ordinary trades and occupations, physical training, play, or the daily routine activities of life. Our curative shops are now being organized, and graduated on the principle which will enable us ultimately to isolate, classify, repeat and to a limited degree, standardize and control the type of movements involved in the particular occupational and recreational operations. The patient's attention is repeatedly called to the particular remedial movements involved; at the same time the movements have the advantage of being initiated by the patient and of forming an integral and necessary part of a larger and more complex series of coordinated movements. The purposive nature of the movements and the end products of the work offer a direct incentive for sustained effort; the periodic measurement of the increase in range and strength of movement makes it possible for the patient to watch

his recovery from day to day; and frequent comparisons between his progress curve and that of others offers an excellent opportunity to explain and to help him overcome plateau periods or regressions which necessarily occur. In addition to evoking an attitude of interest, cheerfulness and optimism in the patient and by showing him that he is really making progress, the records also enable the examiner to determine which mode of treatment leads to the greatest and most consistent gains in a particular case and they directly encourage voluntary effort and personal initiative on the part of the individual.

The method of formal mechano-therapy, or formal medical gymnastics, which has been so widely used, consisting of exercises of a quasi-passive nature on special apparatus designed to give opportunity for the execution of repeated movements involving specific joints has the advantage of isolating particular joints from the rest of the body, and allowing for the construction of special apparatus designed to give repeated exercises under controlled conditions for limited periods of time. While these two methods are not materially exclusive the aim of this paper is to set forth, some of the advantages of occupational therapy as applied at Walter Reed Hospital.

The disadvantages of the mechano-therapeutic method are that the human body is more than a machine when voluntary movements are concerned and it is very doubtful whether the formal repetition of movement from a mechanical source is of maximum therapeutic value in increasing the amount of movement either in the affected part or as an integral part of the larger co-ordination of movement of which each particular movement must ultimately be an essential part. The application of mechano-therapy does not allow for the personal initiative of the subject, gives little or no opportunity for voluntary effort, and offers little incentive for sustained effort. The second type of mechano-therapy which has some advantages over the traditional method is that formulated and worked out by Captain Bott of the University of Toronto. This type of therapeutic exercise is based on the general presuppositions that:

"Simple mechanical appliances for bringing specific disabilities into operation are indispensable and the appliances are fitted with metrical devices which record and stimulate daily performance by appealing to the eye and ear. In this way, a patient is brought face to face with his incapacity and is encouraged to use his whole power to overcome it. The psychological basis of this treatment differs from that of the curative workshop in requiring the patient to concentrate upon rather than to forget this injury. The advantage is that he attacks his disability directly, watches his improvement from day to day, and aims at a consistent recovery."

The chief disadvantages of the method as stated above, are that this treatment is isolated and no provision is made for the inter-co-ordination with the other movements of which a particular movement must ultimately become a part; there is little or no evidence

that either initiative or improvement gained in a formal exercise can be transferred to another occasion or to other types of movements.

In the curative shops special projects, special machines and special tools are set aside for strictly curative cases, and the instructors check the movements which each man makes in order to see that special joints are not favored or over-fatigued. A distinct advantage possessed by the work-shop type of therapy consists in the fact that the patient here is a member of a social group and turns out a tangible product of economic value; he is thus brought to full realization of his social fitness and economic usefulness—a factor which is of inestimable value in encouraging and inspiring the patient. He also notes from day to day in the psychological laboratory and shops the increase in functional restoration and is offered opportunities to try the same type of movement in other allied activities.

III Procedure in Assigning Cases in Curative Shops

When, in the opinion of the surgeon, a patient is ready for work in the curative shops, he is sent with a medical prescription to the interviewing office of the Reconstruction buildings. The prescription is checked in a manner similar to plate 2 (which precedes) in order that the Reconstruction force may know the functional result to be attained.

In a general way the work in Occupational Therapy may be divided into the following classes: Occupational, curative and vocational, but no sharp line of demarcation is possible in many cases. It is with one class of curative cases only, that we are dealing in this paper.

The above slip shows a typical prescription, and is that made out for Pvt. A. H. In the interviewing office, Form No. 58, Medical Department, U. S. Army, is filled out by the interviewer, and in this, recommendation is made for the immediate training which seems advisable for the man, from the occupational and curative point of view. The patient then goes to the Psychological Laboratory with the register and medical prescription. Here measurements are taken of the extent and strength of voluntary movement in the affected part, and the case is further analyzed from the psychological standpoint given by the interview sheet, and from observations and conversations with the man himself. On the basis of these three factors, the man is assigned to definite work in the shops for the prescribed number of hours each day.

For the correct selection of work to be given, the following factors are taken into account:

First: The work must be one which involves as an essential part the movements required by the prescription, or in which these movements recur from time to time as the work is performed by

the normal individual. In order to discover the activities in which certain specific movements were thus involved, a survey was made of all the shop and ward activities, and insofar as it was possible by observation and practice, each activity was analyzed into its constituent movements. In Section VI are given two typical analyses which were made to meet a practical situation and are included here merely as suggestive, and in the hope that further and more specific work in this line will be made in other hospitals. From these analyses it has been possible to isolate the activities in which a specific movement is necessary or is recurrently involved. For instance, the adduction and abduction of the left wrist is essentially involved in turning the large unmounted plate while making the curves in engraving, where the tool is held with the right hand. Another activity calling for pronounced and continuous adduction and abduction and extension-flexion of the thumb, is in weaving on the Gobelin Tapestry Loom. With the possibility of the various activities in mind, the psychologist in consultation with the surgeon decides in which of these the patient should be placed for curative treatment.

Second: Where more than one of the activities are equally desirable from the curative standpoint, the one with a vocational outlook is assigned in accordance with the patient's choice and the recommendations of the vocational advisor. Frequently the patient is taken through the shops to observe and to try out the work. Occupational Therapy in work with a vocational outlook is, as a rule, preferable and most desirable from many points of view, but frequently patients whose stay in the hospital is short, prefer to work along the lines of an avocation rather than to return to vocational experiences. An example of a vocational shifting is illustrated by that of a patient who was a machinist and who, being unable to return to his former heavy work, has been taking light woodworking and mechanical drafting.

As an illustration of an avocational interest, a man who has been or intends to be a machinist, and who is not yet able to take up such heavy work, frequently chooses the jewelry shop, in which he is working with metals and with tools. The rug weaving or leather work frequently represents a purely avocational interest. As the curative work is usually limited to one or two hours, the patient frequently takes up as occupational work, a study of allied subjects of an academic nature which do not involve exercise.

After the patient has entered upon the work, he returns to the Laboratory at regular intervals for the measurements of the extent and strength of voluntary movement, in order that he may see his progress in a concrete manner as illustrated by progress curves. If there is constant gain, he is encouraged, and the instructors and the surgeons know that the treatment is of the proper kind. If there is a drop in the record, the reason is sought. This may be due to absence of occupational or physio-therapeutic treatment, or to the general physical condition of the man. This is also made clearer

to the patient by frequent comparison between his curves and those of other patients with similar plateaus or regressions.

IV Typical Assignments in Occupational Therapy

Diagnosis: G. S. W. Thumb, left hand. Healed. Limitation thumb.

Prescription: Increased thumb motion; adduction-abduction, flexion-extension, circumduction thumb.

Assignment: Rug weaving department, work on Gobelin tapestry loom, where the separating and holding out of the threads of the warp is done by abducting and extending the thumb, with also slight circumduction. The amount of strength required depends on the tightness of the warp.

Progress: Worked from the date of assignment, December 29, to January 13, when he was taken ill with the influenza, for one hour or one hour and a half regularly each day. Could not use the tightly drawn threads, so was put on those requiring less strength. In the beginning had no active movement in the thumb; but was obliged to use the other hand in placing over the thumb the threads which the thumb normally should lift. After a week the thumb itself did a part of the work, though still assisted by the other hand. In the last few days of the work the thumb could lift by its own action a few of the threads.

Marine C. S. A.—*Fingers and Wrist.*

Diagnosis: (a) Amputation thigh. Right upper middle third healed. (b) Shoulder left, limitation motion. Flesh healed. (c) Forearm left (involving median nerve.) Flesh healed.

Prescription: Normal action of fingers of left hand and forearm with especial reference to wrist, thumb and index.

Assignment: Engraving. In "wriggling" with left hand on plate mounted on wooded block, grasping the tool with left hand gives flexion of the fingers, and the desired flexion of all joints of thumb is attained by a specially adapted handle of dental compound. Extension required in releasing it. Steady though slight pronation-supination. This alternated with right hand "wriggling," which gives flexion of metacarpophalangeal joints of fingers of left hand and extension of interphalangeal joints of fingers and thumb in holding the block. Wrist extension-flexion in turning the block.

Also typewriting for finger flexion-extension and abduction-adduction.

Progress: At first patient could not hold the tool in his left hand in a way to enable him to engrave. After three daily appointments of one hour each, he was able to "wriggle" any ornament and was enthusiastic over the seeming improvement in the function of his left index finger. From November 8, when he began the work, to December 23, when he dropped it temporarily to go on a furlough,

the composition handle was changed three times to adapt it to the constantly increased power of flexion in the thumb and fingers. In typewriting he was able to use all fingers from the first, but tired easily. Function fully restored. See plate No. 3, patient at left,



Plate 3

Engraving which can be done with tools held in right or left hand as required. Tools with especially adapted handle in foreground.

Pvt. G. N.—Elbow.

Diagnosis: Limitation of movement, right elbow.—G. S. W.

Prescription: Mobilization right elbow in flexion-extension by work for one hour a day avoiding undue fatigue.

Assignment: Carpentry. First project was in making a cigarette case for the Red Cross, doing the entire work himself and working at it in all his spare time. After this he made filing boxes. In both these projects the hammering with small hammer and nails required very slight elbow motion, but the sawing and planing of the wood necessitated elbow extension and flexion. The measurements of the range of voluntary movement showed a slight but steady increase from October 4 to November 2:

Oct. 4, 21.0 degrees; Oct. 11, 24.5 degrees; Oct. 14, 25.3 degrees; Oct. 25, 28 degrees; Oct. 29, 29.8 degrees; Nov. 2, 29 degrees.

Pvt. B. G.—Back.

Diagnosis: Traumatic acute sacro-iliac strain.

Prescription: Free motion of spine; only light spinal exercise advisable in beginning.

Assignment: Light greenhouse work, where bending over the

low benches gives flexion-extension of back; work at higher benches requires only slight flexion-extension.

Pvt. G. G.—*Ankle and Toes.*

Diagnosis: G. S. W. Perforating right foot.

Prescription: Motion of toes mid-tarsus and ankle, with precaution that he should not walk far or stand on feet for a long time.

Assignment: Woodshop. Work on the small scroll saw, with treadle action, cutting out picture puzzles. Blocks are placed under the heel on the treadle, an arrangement which requires more extension-flexion of toes and mid-tarsus as well as extension-flexion of ankle.

Measurements taken in the laboratory to show range of voluntary extension-flexion are shown in Table Case I (ankle). Those of voluntary adduction-abduction are the following:

Nov. 25, 67 degrees, Nov. 27, 76.2 degrees; Dec. 2, 76.1 degrees; Dec. 4, 80.3 degrees; Dec. 6, 101.3 degrees; Dec. 9, 94 degrees; Dec. 11, 97.1 degrees.

Measurements of flexion-extension taken in two cases before and after the hour's exercise show improvements of 6.3 degrees and 9.2 degrees.

V—a. Measurement of Range of Voluntary Movement in Stiff Joints (Psychological Laboratory)

As a result of the first case discussed on page 3 it was found advisable to have some definite method of letting the patient know the amount of movement which he was able to make in the disabled joint. The surgeon as a rule measures the passive movement of which the joint is capable, and frequently estimates this directly or by some simple apparatus. There is, so far as we know, no standardized apparatus for this measurement.

It was eminently desirable to have some measure of movement both for incentive to patient and for information of surgeons and instructors. Apparatus was therefore devised and made in the shops, which should measure as accurately as possible the range of voluntary movement possible in any disabled joint in the body. The accompanying plates 4-14 show the types of apparatus in use at present. Further modifications and improvements are constantly being made, and it is hoped that this apparatus may be so perfected and so standardized as to form a common basis of measurement for orthopedic cases. The fact that we are dealing with voluntary movements, makes this essentially a psychological problem.

In taking these measurements, the laboratory conditions are kept as strictly uniform as is possible in order that measurements may be repeated, controlled and standardized. Certain general principles are followed in all cases:

First. The joints adjacent to the joint in question are immobilized as far as possible. Since it was not known how far the range

of movement in a joint was affected by the position or the movement of adjacent joints, and since it was desirable to keep all factors as constant as possible so that at least the relative readings might be accurate, this principle of immobilization was adopted. It is realized that by this method an artificial situation is created, and the actual range of movement may be limited, but if this limitation is constant from day to day, it is possible to obtain the progress of the movement.

Second. As far as possible, incentive in the form of an external stimulus or suggestion is eliminated during the actual movement. In the preliminary sitting, this rule is broken if the patient is not familiar with measurements, or does not seem to have grasped the idea of the possibility of noting his gain from day to day, and of breaking his own record. In such cases, the first sitting is devoted to giving the patient this concept of voluntary action. In following the assignments, the patient is not told what record he is making until after the readings are completed, then he is given full information and these readings compared with those of the previous sittings. Though there are undoubtedly advantages in allowing the patient to know exactly what he is doing at the time he is doing it, and even urging him on to make one or two points more, this encouragement formed such a variable factor that it seemed necessary to rule it out in order to obtain a true measure of progress.

Third. The recording is made of the maximum of movement in both directions and the difference taken to give the range or extent of movement. Three readings are taken of this range, and the average of these taken as the extent of movement for that sitting.

Fourth. The numerical data thus gained are tabulated and curves are plotted from them in order that the patient may have visual evidence of his progress transcribed into graphic form which the patient may see for comparison.

Fifth. As far as possible note is made of accompanying irregularities in movement and unusual sensation, such as pain or undue pressure, with introspective notes.

Sixth. Note should be made of all treatments and activities of the joint in question since last sitting, as well as the general physical condition at the time of the measurement.



Plate 4

Illustration of method of measuring amplitude of flexion-extension of finger joints.



Plate 5

Preliminary apparatus for measuring the amplitude of flexion and extension of the wrist. (Discarded for type below.)

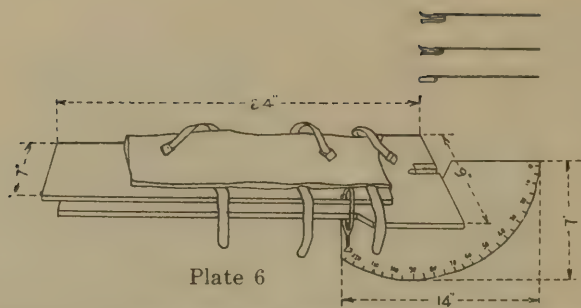


Plate 6

Sketch of apparatus for measurement of amplitude of flexion and extension of finger joints.

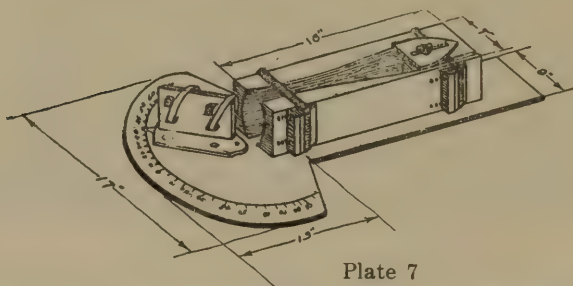


Plate 7

Sketch of new apparatus for measuring amplitude of flexion and extension of the wrist.

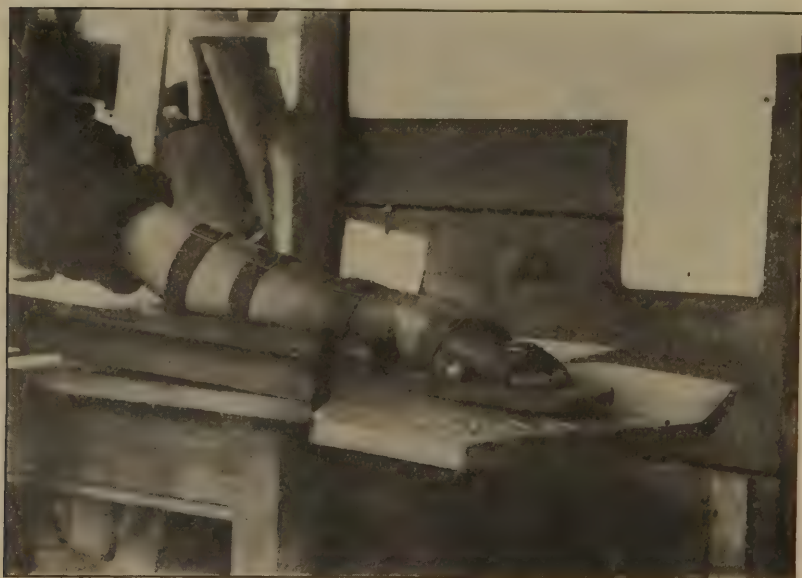


Plate 8

Measurement of adduction—abduction of the wrist.

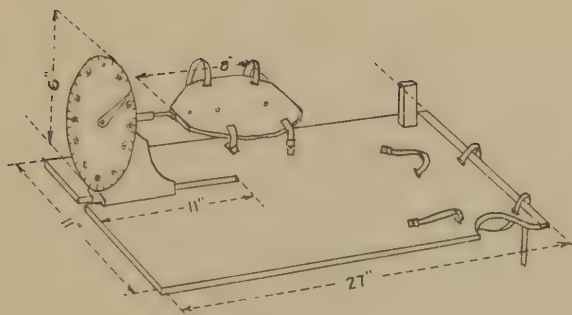


Plate 9
Sketch of apparatus for measuring pronation
and supination of forearm.

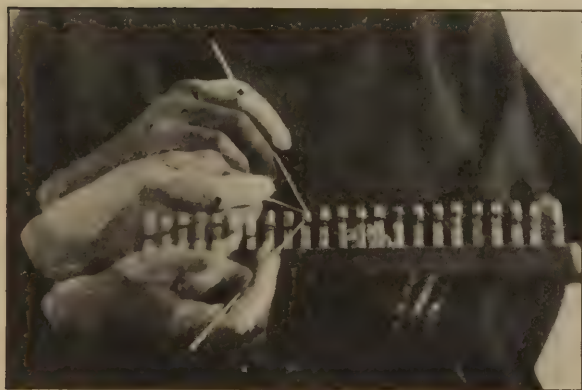


Plate 10
Circumduction of the wrist as used in
rake knitting, from below upward.

Range of Movement of Fingers in Degrees Extension-Flexion

Pvt. C. B.

Dates.*	FIRST JOINT				SECOND JOINT				THIRD JOINT			
	II.	III.	IV.	V.	II.	III.	IV.	V.	II.	III.	IV.	V.
Nov. 17.	16.0	43.2	10.8	14.6	.....	.....	.....	.....	.....	.....	.....	.....
Nov. 27.	.....	.....	.....	.....	26.2	61.3	20.6	24.3	.....	.....	.....	.....
Dec. 2	.....	.....	.....	.....	.....	.....	.....	.....	57.0	78.8	49.0	58.6
Dec. 4	25.6	51.0	11.6	11.1	.....	.....	.....	.....	.....	.....	.....	.....
Dec. 6	.....	.....	.....	.....	63.1	91.3	55.5	31.6	.....	.....	.....	.....
Dec. 9	.....	.....	.....	.....	.....	.....	.....	.....	68.4	88.3	54.3	62.3
Dec. 11.	37.0	61.1	16.1	20.8	.....	.....	.....	.....	.....	.....	.....	.....
Dec. 13.	.....	.....	.....	.....	48.6	86.8	50.0	29.3	.....	.....	.....	.....
Dec. 17.	.....	.....	.....	.....	.....	.....	.....	.....	72.6	83.1	54.3	61.3

Pvt. S. F.

Dates.	FIRST JOINT				SECOND JOINT				THIRD JOINT			
	II.	III.	IV.	V.	II.	III.	IV.	V.	II.	III.	IV.	V.
Nov. 18.	39.7	56.0	38.0	15.0	.....	.....	.....	.....	.....	.....	.....	.....
Nov. 20.	.....	.....	.....	.....	70.5	81.7	.....	56.3	.....	.....	.....	.....
Nov. 22.	.....	.....	.....	.....	.....	.....	.....	.....	69.7	69.3	65.0	60.3
Nov. 25.	60.5	79.1	50.6	26.0	.....	.....	.....	.....	.....	.....	.....	.....
Nov. 27.	.....	.....	.....	.....	60.0	78.6	.....	44.1	.....	.....	.....	.....
Dec. 3	.....	.....	.....	.....	.....	.....	.....	.....	85.1	85.5	78.8	70.5
Dec. 4	61.8	70.8	59.0	32.8	.....	.....	.....	.....	.....	.....	.....	.....
Dec. 6	.....	.....	.....	.....	101.3	113.1	.....	58.5	.....	.....	.....	.....
Dec. 9	.....	.....	.....	.....	.....	.....	.....	.....	78.0	84.5	76.0	53.3
Dec. 16.	84.3	85.0	45.6	31.0	.....	.....	.....	.....	.....	.....	.....	.....

Table 1

Type Cases in Extension-Flexion

Range of Movement in Fourth Finger, Third Joint, in Terms of
Degrees, Also Wrist, Elbow, Knee and Ankle

FOURTH FINGER, THIRD JOINT.										
Case	Measurement.			Increment.		Per cent.		Days.		
	1st Period.	2nd Period.	3rd Period.	Per Cent. 1st Increment.	Per Cent. 2nd Increment.	Pct. 1st Increment.	Pct. 2nd Increment.	Total Per Cent	Number Days.	
I. (Left) . . .	13.4	24.4	46.2	11.	21.8	82.	163.	245.	74	
II. (Left) . . .	34.7	41.	47.2	6.3	6.2	18.2	17.8	36.	42	
III. (Left) . . .	53.	66.8	73.5	13.8	6.7	26.	12.6	38.6	30	
IV. (Right) . . .	38.	54.8	61.3	16.8	6.5	44.2	11.8	56.0	28	
WRIST.										
I. (Left) . . .	47.2		144.7	97.5		206.		206.5	5	
II. (Left) . . .	52.6	73.6	85.7	21.	12.1	39.9	23.	62.9	98	
III. (Left) . . .	117.8	137.3	147.7	19.5	10.4	16.5	8.8	25.4	53	
IV. (Right) . . .	131.5	153.2	190.5	21.7	37.3	16.5	28.4	44.9	15	
ELBOW.										
I. (Right) . . .	75.	83.9	91.5	8.9	8.	11.8	10.6	22.5	11	
II. (Right) . . .	22.7	26.7	29.4	5.	2.7	17.6	11.8	29.5	29	
III. (Left) . . .	18.3	35.3	33.	17.	2.3	92.9	12.5	80.3	21	
IV. (Left) . . .	66.7	74.3	76.	7.6	1.7	11.4	2.5	13.9	51	
KNEE.										
I. (Left) . . .	17.8	68.8	72.	51.	3.2	287.	18.	305.	34	
II. (Right) . . .	88.2	96.5	106.6	8.3	10.1	9.4	11.4	20.8	5	
III. (Left) . . .	19.2	21.1	22.4	1.9	1.3	9.9	6.7	16.6	39	
IV. (Left) . . .	55.2	83.2	89.3	28.	6.1	507.	11.	61.7	23	
ANKLE.										
I. (Right) . . .	43.9	52.6	57.3	8.7	4.7	19.8	10.7	30.5	64	
II. (Left) . . .	32.2	43.5	72.7	11.3	29.2	35.	90.6	125.6	17	

Table 2



Plate 11

Apparatus for measurement of
elbow extension and flex-
ion cases.



Plate 12

Measuring the range of voluntary
inversion-eversion of the
ankle.

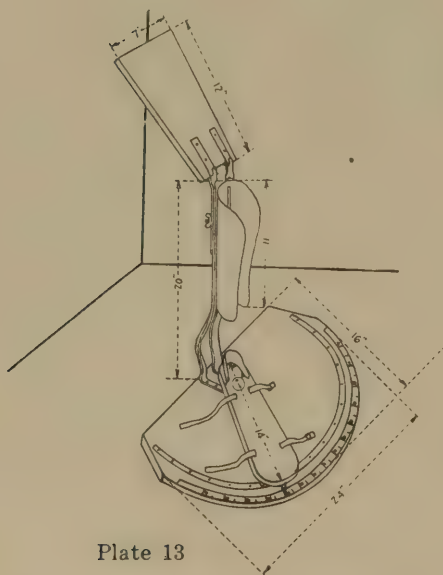


Plate 13

Sketch of apparatus for the mea-
surement of the adduction-
abduction of the ankle.

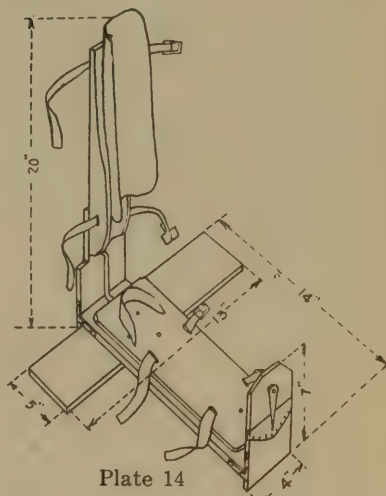


Plate 14

Sketch of apparatus for measur-
ing the amplitude of ever-
sion and inversion of ankle.

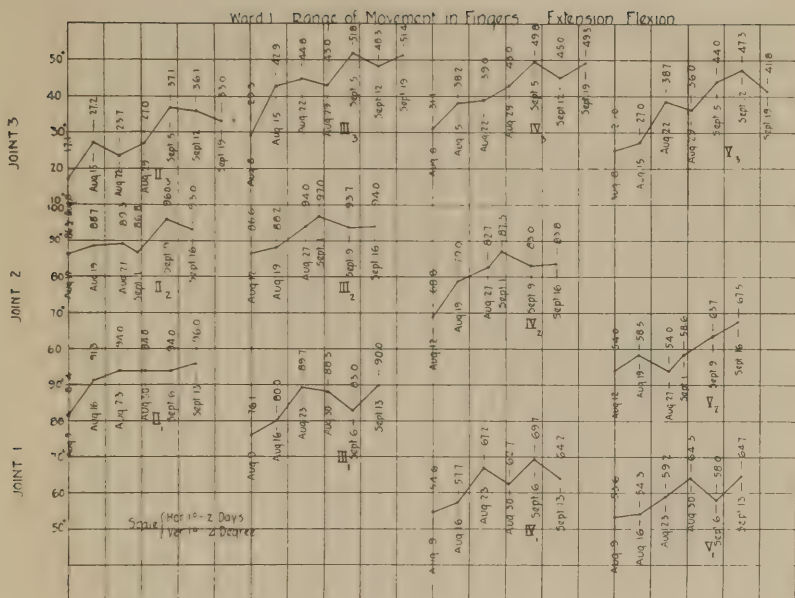


Plate 15

Progress curves of extension and flexion of fingers.

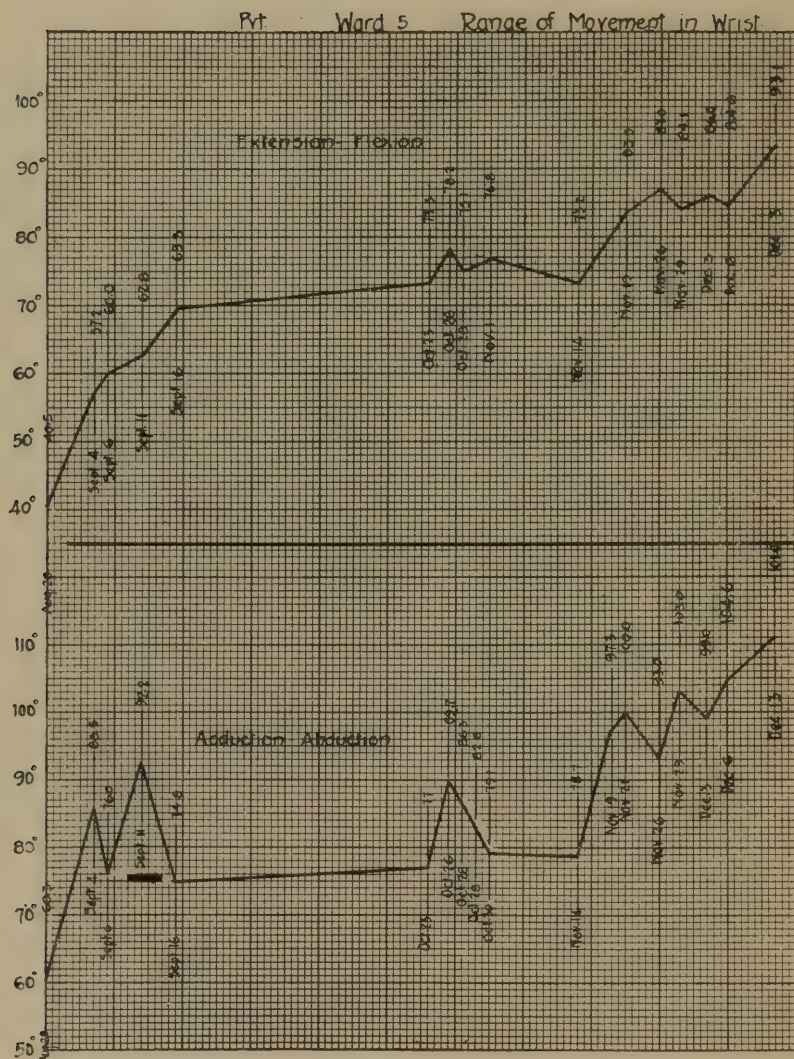


Plate 16

Progress curves of flexion and extension and adduction and abduction of wrist.

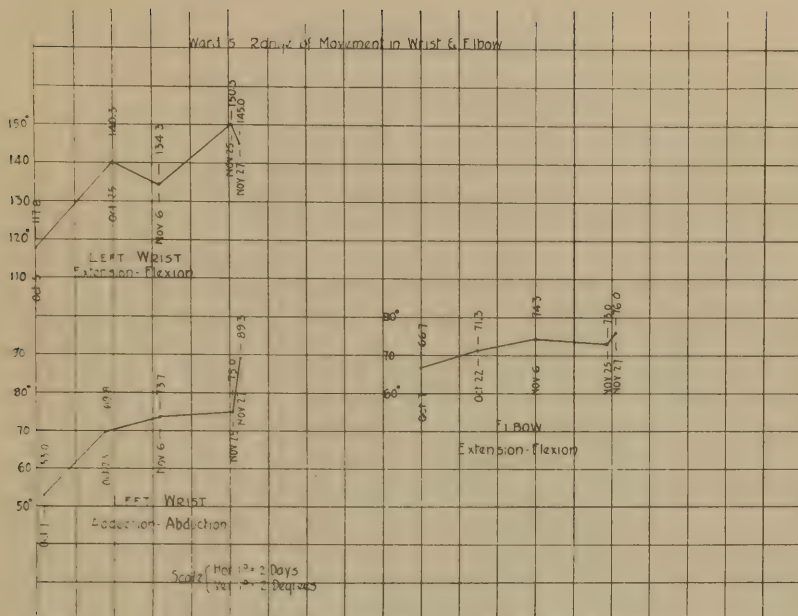


Plate 17

Progress curves of extension and flexion, adduction and abduction of wrist and extension and flexion of elbow.

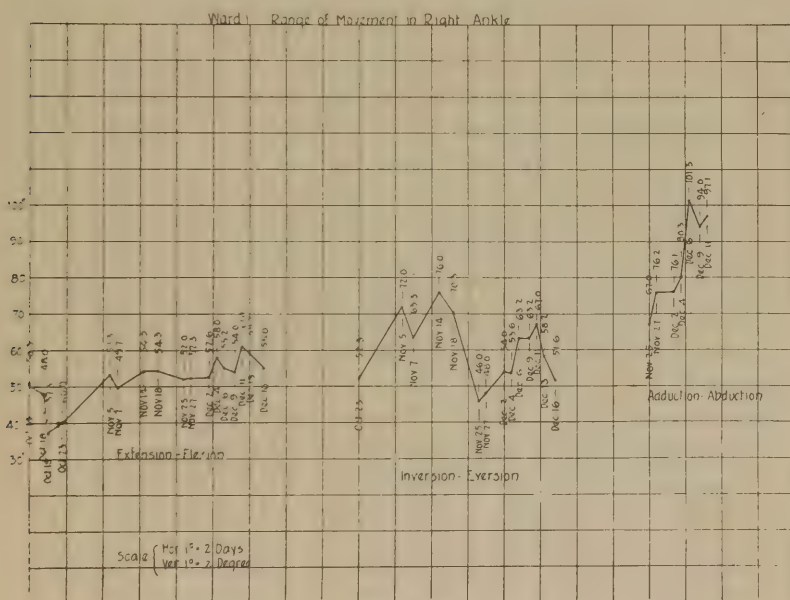
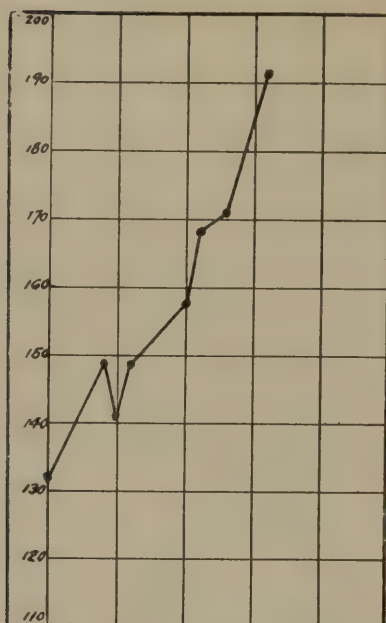


Plate 18

Progress curves of extension and flexion, inversion and eversion, and adduction and abduction of ankle.



Progress course of improvement in
flexion-extension of wrist.

Plate 19

b. Strength of Voluntary Movements in Stiff Joints (Psychological Laboratory)

Measurements of muscular strength in cases of partially stiffened joints are made, first, in order to determine the initial degree of disability in the limb involved, by comparing the strength of the weakened joint muscles with the strength of like muscles in the uninjured limb. With a knowledge of the amount of strength in a partially disabled limb, the patient can intelligently be assigned to curative work which he will be able to perform, and which will not be too strenuous. By subsequent measurements check can be made on rate and extent of improvement. If work is not showing results which seem to be sufficiently beneficial, the patient may be re-assigned to more suitable work. By continuing the measurements it is possible to determine when complete recovery has been attained.

The muscle testing is done with spring-balance scales by the Martin method. Commercial scales such as can be bought in any hardware store are used, a few modifications being made to render them more suitable. The most important modification is the insertion on the dial of a small runner, which slides with the minimum amount of friction necessary to keep it in any position against the

force of gravity. When a pull against resistance is made with the scales the pointer on the dial carries the runner with it. Upon cessation of the pull, the pointer returns to the zero reading while the runner remains at the point reached in the maximum pull, thus making the scales self-registering. The runner is then pushed back to the zero point by hand.

The Martin method* has a double advantage in that it makes possible testing under constant conditions of both leverage and position. The pull of the scales is made against a fixed position assumed by the patient. Two persons are required in making the tests, an operator and an assistant who co-ordinate the pull of the scales with the resistance of the muscle and attend carefully to the maintenance of correct positions of the limb and of the relationships of leverage. The command "hold back" by the operator is the signal for the patient to innervate the muscle being measured and for the assistant to commence pulling. The pull is made along accurately determined lines in opposition to the pull of the muscle. A steady increasing pull is maintained until resistance of the muscle has been overcome, as shown by the movement in the direction of the pull of the scales of the limb or part of the limb being measured. The reading of the scales is then taken in pounds or fractions of a pound. Three readings are taken for each muscle, and the average taken. To avoid conditions of fatigue the three measurements of the same muscle are not taken in direct sequence.

For the lower extremity the muscles which govern the following movements can be measured: Hip flexion, extension, adduction and abduction; knee flexion and extension; plantar flexion, dorsiflexion, inversion and eversion. All of these measurements are taken with the patient lying on a table, and the pull of the scales is in a horizontal plane.

In measuring the elbow flexor and extensor muscles the subject lies on the back with the forearm perpendicular to the table. In measuring the muscle moving the shoulder the subject stands squarely against a post or similar firm support and braces with the opposite arm. For the wrist muscles the arm is held in a horizontal plane and properly braced. The subject is in a standing position. The Smedley hand dynamometer is used for the hand.

In all cases, the part of the extremity proximal to the joint moved by the muscle being measured is braced so that the pull of the scales will always be against only the particular muscle involved. To obtain accurate results it is most important to preclude the use of any

*For a more complete description of the Martin method of muscle testing see R. W. Lovett: "The Treatment of Infantile Paralysis," 2nd Ed. 1917, Chap. VII, also R. W. Lovett and E. G. Martin: "The Muscle Test for Infantile Paralysis—a Description of the Technique," Amer. Jour. Orth. Surg., July, 1916.



Plate 20

Illustration of method of measuring strength of muscles involved in flexion of wrist.



Plate 21

Illustration of method of measuring strength of muscles involved in flexion of elbow.

but the muscle to be measured, and the utmost care must be exercised in keeping conditions of position and leverage constant.

Tests on patients of this hospital were begun on December 18, 1918. In practically all cases of men given curative occupational assignment, measurements are taken at the time of assignment and three times a week thereafter. The results in a few typical cases are given below:

• Case I. J. S. Gunshot wound through forearm just below the elbow, with a slight wound just above the wrist. Resultant loss of strength in flexion and extension of elbow and fingers, and thumb abduction and adduction. Measurements of the muscles moving the elbow and metacarpophalangeal joints were as follows: (Readings in pounds.)



Plate 22

Measuring strength of muscles controlling elbow flexion. Note scar at elbow.

	Left arm	Right arm (normal)	Percent of normal strength in left arm
Elbow			
Flexion	38.0	66.0	57.5
Extension	32.0	47.0	68.0
Thumb			
Adduction	14.3	20.5	69.7
Abduction	7.0	6.3	111.1
I Flexion	11.0	12.2	90.1
Extension	4.0	6.7	59.7
II Flexion	11.0	12.7	86.6
Extension	4.7	5.5	85.5
III Flexion	11.0	11.5	95.7
Extension	5.5	5.7	96.5
IV Flexion	9.0	8.5	105.8
Extension	4.5	4.3	104.6

Average of 85.9 percent normal strength in left arm. In this case almost complete recovery had been attained when the measurements were begun.

Measurements of the weakened muscles of the left arm taken more than two weeks apart were as follows:

	Dec. 20	Jan. 6	Percent of gain in strength
Elbow			
Flexion	38.0	38.0	0.0
Extension	32.0	33.5	4.7
Thumb			
Adduction	14.3	17.0	18.8
Abduction	7.0	6.2	—11.4
Fingers			
I Flexion	11.0	12.5	13.6
Extension	4.0	4.5	12.5
II Flexion	11.0	13.2	20.0
Extension	4.7	4.3	— 8.5
III Flexion	11.0	11.3	2.7
Extension	5.5	4.7	—14.5
IV Flexion	9.0	8.8	— 2.2
Extension	4.4	4.2	— 6.6

Average percent of gain in strength 2.4 percent.

Case II. J. K. Gunshot wound through right shoulder. Well healed, but limited motion of shoulder and elbow remains. Measurements in pounds were as follows:

Muscle	Right Arm		Left Arm (normal)
	Dec. 19	Jan. 9	
Pectoral	29.0	47.7	75.3
Anterior deltoid	30.0	54.3	84.3
Posterior deltoid	23.5	39.7	51.7
Elbow flexor	21.0	33.3	76.3
Elbow extensor	27.0	35.7	68.3

Here the measurements for January 9th show an average gain of 58.6 per cent over the measurements made on December 19. On

December 19 the right arm was found to have 37.3 per cent normal strength as shown by measurement of the left arm, while on January 9 it had improved to 56.1 per cent normal strength. In this case recovery is not nearly so complete as in Case I, and the gain in strength is much more marked.

Case III. J. D. S. Gunshot wound through upper third of right fore arm. Well healed, but muscles still weak and motion somewhat limited. Measurements in pounds were as follows:

Muscle	Right Arm			Left Arm (normal)
	Dec. 30	Jan. 7	Jan. 9	
Elbow flexor	25.7	28.3	28.6	69.7
Elbow extensor	19.0	20.0	26.7	44.0

On December 30, the muscles moving the right forearm are shown to have 40 per cent normal strength. By January 7, the gain in strength is within 43 per cent of normal, while the measurements on January 9 show the muscles to average 50.8 per cent normal strength.

The tests which were begun on stiff joint cases are now being modified so as to be adaptable to amputation cases as well.

VI Examples of Types of Movements Occurring in Various Occupational Activities

DEFINITION* AND ILLUSTRATION.

Extension is the straightening of a joint. Opening the hand is an example of extension of the *finger* joints. Straightening the *wrist* and *elbow* as in reaching for something, movement of the *shoulder* as in bringing the arm forward and downward from a raised position in front of the body (given by Morris Beevor et al., not given by Piersol and Gray), movement of the *neck*, *back*, *hip* and *knee*, as in coming to "attention," *ankle* (plantar flexion) and *mid-tarsus* as in walking on the tip-toe, *toes* as in bending them toward the upper side of the foot, are other examples of extension.

An attempt has been made in the following specific examples of occupational therapy to give a detailed analysis for the specific joints involved. Since, as stated above, one of the advantages of occupational therapy consists in the fact that movements are not isolated, but consist of a series of co-ordinated movements with other joints, it should be noted that as a rule the movements are never limited to one joint. The detailed outline may seem too specific for the average instructor, who may prefer to deal simply with grosser movements. The movements outlined refer to joints and not to special muscles.

*Definitions selected and adopted for standardizing the procedure for instructors in the various curative activities.

EXAMPLES:

I. *Thumb.*

Carpentry: Forcible straightening of the thumb in holding boards in wood working, especially in sawing (see cut), holding and guiding wood in cutting out figures on the scroll saw. **Machine shop:** Holding sheet metal while marking design for cutting. **Engraving:** Extension of interphalangeal and metacarpophalangeal joints in guiding tools, in making curves and in "wriggling;" extension of interphalangeal joints of fingers and thumb, the amount of extension depending upon the size of the block used. **Rug weaving:** Separating alternate threads of warp of the Gobelin tapestry loom; in pulling rags through while weaving rag rugs on Lane loom. **Jewelry:** In holding metal for polishing and sawing, holding articles for polishing on the electric buffer, holding jewelry while filing and polishing with emeries, or in finishing work, holding pliers and twisting wires for chains. **Drafting:** In holding T-square. **Typewriting:** In grasping handle to turn roller. **Modeling:** In pressing the clay on the board for the background in bas relief work. **Ward work:** Forcible extension of joint (interphalangeal joint) in using large handled pliers or punches, active extension (and flexion) of metacarpophalangeal joint in using scissors, pliers or punches. **Gymnasium:** In gymnastics, in using medicine and volley and hand ball. **Miscellaneous:** In piano playing.

Note: Active extension of thumb in releasing all tools and implements in farm or other work.

II. *Fingers.*

Carpentry: Forcible straightening of fingers as in use of whetstone, cabinet scraper, in wood working, painting, sand-paper or wax polishing, holding and guiding wood in cutting out figures on the scroll saw. **Machine shop:** In holding sheet metal while marking design for cutting. In the guiding hand in scraping. **Engraving (left hand):** Extension of all joints of all fingers in working on large unmounted plate; of inter-phalangeal joints in using wooden block with mounted plate (see cut); of inter-phalangeal joints of finger and thumb, amount of extension depending on size of block used. **Rug weaving:** Reaching through shed on Lane loom for pulling rags through, pulling threads and changing sheds on Gobelin tapestry loom. **Jewelry:** In polishing, buffing and holding of flat metals while working on them; metacarpo-phalangeal joints are extended while holding the block while soldering; in all polishing and finishing; extension (and flexion) in chasing and using planishing hammer. **Drafting:** In holding T-square and triangles. **Typewriting:** Extension of index finger of left hand in throwing carriage of typewriter. **Burroughs Adding and Listing Machine:** Extension (and flexion) of fingers. **Modeling:** In pressing clay on background in bas relief work, extension of fingers and thumb in manipulating clay. **Ward work:** Forcible extension in bookbinding, in spreading the paste, in pressing the cloth or paper on back of book; leather

work, in holding leather flat with one hand; in tooling with other, extension of 2d and 3d fingers in holding tool; basketry, in keeping reeds in proper position and in raking reeds into place, cord belting, in reaching for cords to tie the knots and in holding leaders on which the knot is tied; weaving; gymnastic exercises, including the pulling of weights, bearing weight of body on fingers, basket ball, hand ball, use of rackets with large handles in tennis and tether ball. Gymnastics: Medicine, volley and hand ball, gymnastics. Farm: Holding cultivator and light plow handles; active extension of fingers in releasing all tools and implements from the grasp. Leveling and preparing soil in seed beds in green-houses. Miscellaneous: Piano playing.

III. Wrist.

Carpentry: Straightening and bending back of wrist in planing, in wood-carving, in use of post drill press. Machine shop: In turning hand-power drills and grinders, in turning portable crane hoist. Engraving: In returning to initial position when turning block in using block with mounted plate; in dotting, slight flexion (and extension). Rug weaving: Changing sheds on Lane loom by use of over-head bar, throwing shuttle on Lane loom, use of syeater machine (both wrists). Jewelry: In holding articles for buffing with



Plate 23

Jewelry work as illustrated by patient at left offers many of the required movements of the hand and wrist.

the electric buffer, in pulling of wire with tongs. Drafting: Slight extended position in holding ruling pen. Telegraphy: Extended position of wrist in telegraphing and slight movement of same. In Burroughs Adding and Listing Machine: In using lever. Modeling: Extension (and flexion) in constructing armatures in building up figures, heads, etc. Ward work: Flexion (and extension) in making Colonial mats, in weaving, painting, and book-binding. Gymnastics, boxing, pulley weights, horizontal bars. Farm: In using farm tools, including hoe, rake, fork and spade. Miscellaneous: Plastering with trowel.



Plate 24
Typical movements in rug weaving.

IV. *Elbow.*

Carpentry: Straightening of arm as required in planing, sawing, hammering with a heavy hammer and spikes, turning the handle in the post drill press. Machine shop: Shifting of lathe clutch lever, using card belt shifter. Engraving: Slight extension (and flexion)



Plate 25

Modelling, which offers varied movements of the thumb, fingers and wrist.

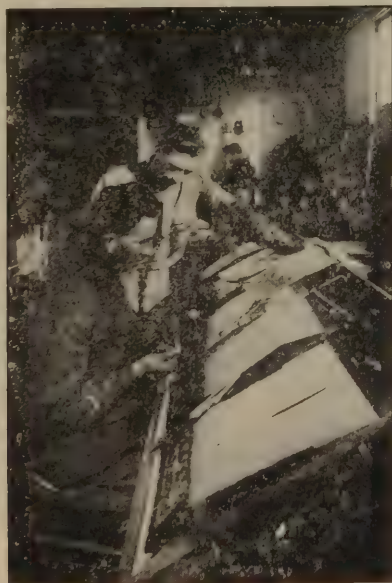


Plate 26

Illustration showing the finger movements in rug weaving.



Plate 27
Two Curative Cases with marked left hand disabilities
working at Gobelin Tapestry loom.



Plate 28
Exercise in sawing the sandpapering involving
the extension of the thumb and little finger
of the left hand.

of left hand in making curves, of right, in dotting. Rug weaving: Use of beater on Lane loom, throwing shuttle through shed on Lane loom, tying of knots on Oriental Rugs, the amount of extension depending on the length of thread; use of sweater machine (both elbows), winding of yarn, reaching up in changing sheds on Gobelin tapestry loom. Jewelry: Extension (and flexion) of elbow in pulling wire in hammering, slight extension (and flexion) in buffing with the electric buffer, in sawing. Drafting: In drawing lines up to approximately three inches, in use of pantograph, machine sketching in general. Telegraphy: Slight, quick extension-flexion. Burroughs Adding and Listing Machine: Slight extension of right elbow in



Plate 29

Orthopedic Cases at Work in the Greenhouses.

manipulating lever. Modeling: Extension (and flexion) in modeling, the amount of extension depending upon size and nature of work. Ward work: Turning the lever in the sock machine, pulling out long cords in making the Macrame belt, working with long reeds in basketry, winding the frame in a Colonial mat. Gymnasium: Gymnastics, boxing, wrestling, bag punching, ball games, horizontal bar, rowing machine, pulley weight. Farm: Garden work, such as separating and hand scuffling, shoveling, spading, raking, hoeing, using hand power horse rake. Miscellaneous: Writing with arm movement.

V. *Shoulder.*

Machine shop: Shifting of lathe clutch lever, using cord belt shifter, using hack saw, filing. Carpentry: Use of levers in post drill press. Rug weaving: Reaching to pull down thread in Gobelin tapestry loom. Jewelry: Slight extension (and flexion) in pulling wire and in hammering. Modeling: Slight shoulder movements in ordinary modeling, the amount varying with size and heaviness of work. Gymnasium: Climbing rope, horizontal bar, playing basket ball, bowling. Farm: Hoeing, raking, sifting soil for green houses, cutting with axe.

VI. *Back.*

Carpentry: Movement from bending to vertical position as in planing, cross-cut sawing. Farm: Light farm work. Miscellaneous: Rowing, gymnastics.

VII. *Hip.*

Carpentry: Work which requires use of foot lathes, jig saw or grindstone with foot power—all these adjusted for long and short strokes to increase the range of hip extension, long edge planing. Machine shop: In using foot power metal lathe, in using foot power grinder. Rug weaving: Slight extension in use of treadles in shifting sheds on Lane loom. Farm: Use of scythe. Miscellaneous: Walking, running, riding bicycle, pressing the foot lever of the printing press; use of nailing machine in shoe shop.

VIII. *Knee.*

Carpentry: In using all kinds of foot power machines, lathes, jig saw, grindstone, treadle machines where leg is forced to a straightened position. Machine shop: In using foot power metal lathe, and grinder. Rug weaving: In use of treadles in shifting sheds on Lane loom, use of foot treadle in machine for winding yarn, slight extension in use of sweater machine. Gymnasium: Gymnastics, dancing, various ball games, rowing machine. Farm: Use of horse rake. Miscellaneous: Using the potter's wheel with disc drive, in bicycle riding, walking or running.

IX. *Ankle.*

Carpentry: Bending foot downward as in use of treadle machine. Machine shop: In using foot power metal lathe and grinder. Rug weaving: Use of treadle on Lane loom and shifting the sheds, use of treadle in machine for winding yarn, slight use of ankle in moving from side to side with sweater machine. Typewriting: Extension (and flexion) in using foot shift key in arm amputation cases. Miscellaneous: Bicycle riding, piano playing, walking over rough ground and down hill.

X. *Mid Tarsus and Toes.*

Same as ankle. Carpentry and machine shop: Special adjustments on the treadle machines, in garden work involving weeding,

transplanting or picking vegetables from bushes where a squatting position is required, work requiring standing on tiptoes. Gymnasium: Games and exercises involving standing on tiptoes. Miscellaneous: Dancing.

FLEXION, DEFINITION AND ILLUSTRATION.

Flexion is the bending of a joint. Closing the hand as in grasping an object is an example of flexion of the *finger* joints. Movement of the *wrist* as in touching the inside of the forearm with the fingers, *elbow* as in bringing the hand to the face, *shoulder* as in raising the arm forward and upward (see note above), *neck*, *back* *hip* and *knee* as in picking up something from the ground, *ankle* (dorsal flexion) as in walking on the heels, *toes* and *mid-tarsus* as in bringing the toes toward the sole of the foot, are other examples of flexion.

EXAMPLES, SHOPS:

I. *Thumb.*

Carpentry: Bending the thumb as in grasping any tool, the amount of flexion depending upon the size of the tool handle. Machine shop: Grasping wrenches, hack saw, files, breast and hand drills and other tools as hammer and cold chisel. Strength of grip can be graded by size of tool, proportioned to the work. Gripping of tongs or rod in blacksmith work. Engraving: In using wooden block with mounted plate, small block requiring flexion of all joints, of the right hand in using regular graver's block in dotting. Rug weaving: Reaching to pull down shed in Gobelin tapestry loom, holding of needle in weaving rugs, holding comb for beating down knots, holding yarn in winding machine. Jewelry: In gripping all the tools (and extension in releasing them). A varied amount of extension in grasping tools with handles of various sizes down to the fine bits of stones, metals, etc., in holding block for soldering, in holding mouth blow pipe, in twisting wires, etc. Drafting: In grasping any drafting instrument. Telegraphy: In holding key. Modeling: In grasping tools and manipulating material. Gymnasium: Gymnastics, boxing, baseball (batting), horizontal bars, pulley weights, rowing machine, fencing. Farm: Grasping any tool in garden or greenhouse work.

II. *Fingers.*

Carpentry: Bending fingers as in grasping all kinds of tools, the amount of flexion depending upon the size of the handle. Machine shop: Grasping wrenches, hack saw, files, breast and hand drills and other tools as hammer, cold chisel, strength of grip being graded by size of tool, proportioned to the work; gripping of tongs or rod in blacksmith work. Engraving: In making curves flexion of all joints in fingers of right hand, in using wooden block with mounted plate (see cut), flexion of metacarpo-phalangeal joints, small blocks requiring flexion of all joints; flexion of all fingers

in using regular graver's block, flexion of right hand in firm grasp of tool in dotting. Rug weaving: Catching and pulling down thread in the Gobelin tapestry loom, holding of needle in weaving rugs, holding comb for beating down knots, holding yarn in winding machine. Jewelry: In gripping all the tools (and extension in releasing them). A varied amount of extension in grasping tools with handles of various sizes down to the fine bits of stones, metals, etc., in holding block for soldering, in holding mouth blow pipe, twisting wires, etc. Drafting: In grasping any drafting instrument. Telegraphy: Flexion of third finger in holding key. Typewriting: In grasping handle to turn roller, in striking keys. Burroughs Adding and Listing Machine: Extension (and flexion) of fingers. Modeling: In grasping tools and manipulating material. Ward work: In practically all the hand crafts, the amount of flexion varying with the size of the object grasped, from the large handled pliers, punches, baskets, mat frames, to fine reeds, beads, needles, etc. Gymnasium: Gymnastics, boxing, wrestling, fencing, baseball, rowing, pulley weights, wrist machine, dynamometer (tests), squash (tennis). Farm: In grasping all kinds of tools. Practically all movements occurring in farm work.

III. *Wrist.*

Carpentry: Bending wrist toward inner side of arm as required in wood carving, use of hand drill. Machine shop: Using breast drill, grinders, hand power drills. Engraving: In making curves (left hand), in working on large unmounted plate, flexed position of wrist, in using wooden block with mounted plate, flexion in turning block, slight flexion (and extension) of right hand in dotting. Rug weaving: In turning bar in changing sheds on the Lane loom, use of handle on sweater machine, throwing shuttle on loom. Drafting: Sketching. Burroughs Adding and Listing Machine: In using lever. Gymnasium: Gymnastics, wrist machine, boxing, baseball, volley ball, medicine ball, horizontal bar, squash. Farm: Using sickle, sowing seeds, preparing soil by hand in greenhouses. Miscellaneous: Turning moving picture machine, painting.

IV. *Elbow.*

Carpentry: Raising forearm as in hammering large spikes with a heavy hammer, planing, filing, painting, sand papering, scraping. Machine shop: Hack sawing, filing, hammering metal. Engraving: Slight extension (and flexion) in making curves with left hand, slight in dotting with right hand. Rug weaving: Use of beater in packing the rags on Lane loom, pulling reeds to change sheds on Lane loom, pulling down threads which open sheds in Gobelin tapestry loom, use of sweater machine, guiding thread on spool machine, untying knots in rug weaving, packing knots on small Oriental rugs. Jewelry: Hammering and sawing. Drafting: Use of pantograph, machine sketching. Telegraphy: Slight, quick flexion (and extension) in sending. Burroughs Adding and Listing Machine: Flexion (and extension) of right elbow in using lever. Ward work:

The hand crafts involving extension of elbow, involves flexion as well. Gymnasium: Gymnastics, boxing, dumb bells, Indian clubs, hand ball, volley ball, medicine ball, pulley weights, fencing. Farm: In using scythe, rake, hoe, shovel, spraying with hand pump. Miscellaneous: In using hand pump, turning moving picture machine, writing with arm movement, piano playing.

V. *Shoulder.* (Involves also forward and backward extension abduction-adduction.)

Carpentry: Planing long boards, use of large hammer or axe, cross cut sawing. Machine shop: Working under automobile (reaching up), hack saw filing. Rug weaving: Reaching to pull down thread in Gobelin tapestry loom. Gymnasium: Gymnastics, volley ball, tennis, squash, pulley weights. Farm: Hoeing and raking, digging with mattock, using flail, any work in raising the arm, such as picking fruit from over head.



Plate 30

Telegraphy offers light exercise in the extension and flexion of partially ankylosed joints of the wrist. The first patient has an artificial right arm and a stiff wrist in the left.

VI. *Hip and Back.*

Carpentry: Flexion of back in planing long boards, in cross cut sawing. Of the hip in using foot lathes adjusted for long or short strokes to increase the range of hip flexion, use of foot lathes, jig saw or grindstone with foot power—all these adjusted for long and short strokes to increase the range of hip flexion, long edge planing. Machine shop: Of the back in automobile work in general. Note: Only slight flexion of back required in general machine work. Of the hip in foot power machines, foot power at-



Plate 31

M. G. at work on Lane Loom showing extension of wrist and elbow and flexion of fingers in grasping the beater.



Plate 32

Curative exercise in planing for injury to the left wrist.



Plate 33

Curative work requiring flexion, extension of stiffened elbow.



Plate 34

There is little movement in this patient's left arm and fingers.
Wood carving gives light exercise.



Plate 35

Work requiring pronation and supination of
fore arm of right arm and flexion of fin-
gers of left hand as illustrated by case at
left of picture.

tachments to emery grinder, lathe. Rug weaving: Slight flexion of the back in fitting loom on table. Of the hip, slight, in use of treadles in shifting sheds on Lane loom. Gymnasium: Of the hip in gymnastics, walking and dancing, and any active game. Farm: Light farm work which requires stooping of the back. Picking flowers and vegetables or any work which requires squatting; of the hip, use of horse rake. Miscellaneous: Back, rowing; hip, walking, running bicycle riding.

VII. *Knee.*

Carpentry: Use of all kinds of foot power machines, lathes, jigsaw, grindstone, treadle machines where leg is forced to a straightened position. Machine shop: Use of emery grindstone with foot power attachments, (any foot power machinery, such as lathe or grindstone). Rug weaving: Use of treadles in shifting sheds on Lane loom, use of foot treadle in machine for winding yarn,



Plate 36

Left hand planing for flexion-extension of elbow.

slight extension in use of sweater machine. Gymnasium: Gymnastics, walking, dancing, almost any game. Farm: Weeding, picking low-growing flowers and vegetables. Miscellaneous: Using the sewing machine, foot power printing press, bicycle riding, walking, running, using the potter's wheel with the disc drive.

VIII. *Ankle.*

Carpenter Shop and Machine Shop: Use of all foot power machines. Rug weaving: Ankle and toe in sweater machine (movement from side to side). Gymnasium: Gymnastics, almost any game which requires foot work, dancing. Farm: Garden work which involves weeding, transplanting, or picking vegetables from low bushes. Miscellaneous: Bicycle riding, piano or pianola playing, sewing machine.

IX. *Toes and Mid-Tarsus.*

Carpentry: Treadle machine with especially blocked or hinged treadle, somewhat involved in all movements. Listed under ankle flexion.

ABDUCTION, DEFINITION AND ILLUSTRATION.

Abduction is movement away from the body as the outward movement of the fingers or wrist with the palm up and thumb out,



Plate 37

Light treadle work with specially prepared treadle for extension of the right ankle.



Plate 38

A patient with disabled knee
working on a specially
adapted grindstone.



Plate 39

Light treadle work with specially prepared
treadle for extension of the right ankle.

shoulder movement as in raising the arm sidewise or in moving the arm back of the body (lateral abduction backward extension or "backward" movement by Piersol), hip movement in sidewise outward movement of the leg. Abduction of the ankle as in walking on the inside edge of the foot is sometimes called eversion.

EXAMPLES, SHOPS:

I. *Thumb.* (Also involves extension.)

Carpentry: Abducted position of the thumb in guiding wood on the scroll saw. Machine shop: Holding sheet metal while trac-



Plate 40

Special work in planing for a case with sacroiliac sprain.

ing design for cutting. Engraving: Holding mounted plate, Rug weaving: Turning thumb outward as required in separating alternate threads of the woof and warp of the Gobelin tapestry loom. Jewelry: Abducted position of thumb in holding soldering block, abduction (and adduction) of thumb in placing metal on pitch for shaving and repousse work. Typewriting: Of right thumb in use of space bar: Gymnastics: Abduction (and adduction) of thumb in gymnastics, calisthenics, medicine ball, volley ball, hand ball. Farm: Potting plants. Miscel'aneous: Setting glass.

II. *Fingers.*

Carpentry: Abducted position in guiding wood on scroll saw, holding board in sawing (see cut). Machine shop: Holding sheet metal while tracing design for cutting. Engraving: Abducted position of fingers in holding unmounted plate. Jewelry: Holding flat piece of metal in cutting and in planishing. Drafting: Holding sheet of paper while erasing. Typewriting: Use of fifth finger to operate shift key, very slight abduction (and adduction) of other fingers. Burroughs Adding and Listing Machine: Slight abduction, especially of second and third fingers. Gymnasium: Gymnastics, hand ball, volley ball, medicine ball. Farm: Preparing soil in greenhouses.



Plate 41

Specially adapted machine for long or short stroke for flexion-extension of knee and ankle. Pvt. L. has little movement and is using short stroke.

III. Wrist.

Carpentry: Abduction (and adduction) in hammering with light hammer, using lathe. Machine shop: No special machine, but variety of tools. Engraving: Abduction in turning plate, and adduction in returning to initial position in making curves in working on large unmounted plate, slight abduction in dotting. Rug weav-



Plate 42

J. H. at work on scroll-saw for extension-flexion of knee. This machine can be used in cases where there is too little knee motion to allow the work to be done in a sitting position.

ing: Slight abduction in flattening rugs for rugs, in combing rugs. Jewelry: Abduction (and adduction) of wrist in polishing by hand with emery and rouge papers, turning wire around a mandril to make links for chains, in using mandril for burnished work. Drafting: Cartooning, sketching, illustrating. Gymnasium: Gymnas-

tics, dumb bells, Indian clubs, punching bag, boxing, pool, fencing. Miscellaneous: Writing on blackboard. Ward hand crafts: Holding of rake in rake knitting, punching in brass work.

IV. *Shoulder.*

Machine shop: Lateral abduction (and adduction) with hand bellows, in the lever forge, slight in valve grinding in raising to draw abrasive substance in place. Engraving: Making curves, in working on large unmounted plate, abduction of left shoulder, slight in extent, but with a good deal of strength demanded, if the elbow is held away from the table and the movement controlled from the shoulder, in making curves slightly abducted position of right shoulder, in "wriggling" slight abduction of right shoulder. Dotting, slight abduction-adduction of right shoulder, movement quick, snap-



Plate 43

Specially adapted machine for long or short stroke for flexion-extension of knee and ankle. An example of use of long stroke.

py, but not as strong as in other movements. Rug weaving: Lateral abduction (and adduction) throwing shuttle of sweater machine, in passing rags through sheds on Lane loom. Typewriting: Gymnasium: Gymnastics, Indian club, dumb bells, punching bag, medicine ball. Ward hand crafts: Pulling out cords in macrame belt, pulling reeds through basket.

V. *Hip.*

Rug weaving: Standing before and using the hand lever of sweater machine. Gymnasium: Gymnastics, volley ball, hand ball.

VI. *Ankle.*

Use of all kinds of foot power machines, especially those with velocipede treadles, or of specially tipped pedals to throw the foot upon the inner edge.

ADDUCTION, DEFINITION AND ILLUSTRATION.

Adduction is movement toward the body. Inclining the right or left hand toward body with palm up, thumb out is *wrist* adduction (ulnar flexion.) Spreading *fingers* or *toes* when the movement is toward the body, moving the *shoulder* in lowering the arm sidewise or in bringing the arm across the breast (lateral adduction, "forward movement" by Piersol); with *hip* sidewise moving the leg toward the median line of the body, are examples of adduction. Adduction of the *ankle* as in walking on the outside edge of the foot is sometimes called inversion.

EXAMPLES, SHOPS:

I. *Thumb.* (Involves flexion.)

Shops: Adducted position of thumb in grasping tools, amount of adduction varying with the size of the tool. Typewriting: Right thumb in return from using the space bar. Gymnastics: Adduction (and abduction) of thumb in gymnastics, calisthenics, medicine ball, volley ball, hand ball,

II. *Fingers.*

In shops: Bringing fingers together as in use of tools with small handles. Farm: Preparing soil in greenhouses.

III. *Wrist.*

Carpentry: Adduction (and abduction) in hammering with light hammer and in use of lathe. Machine shop: No special machine, but in general use of tools. Engraving: In return to initial position in making curves in working on large unmounted plate. Rug weaving: Slight adduction (and abduction) in flattening rags for Colonial rugs. Jewelry: Adduction (and abduction) of wrist in polishing by hand with emery and rouge papers, turning a wire around a mandril to make links for chains, using mandril for burnished work. Drafting: Cartooning, sketching, illustrating. Gymnastics: Dumb bells, Indian clubs, punching bag, boxing, pool,

fencing. Miscellaneous: Writing on blackboard. Ward hand crafts: Brass punching.

IV. *Shoulder.* (Adduction rare.)

Carpentry: Slight adduction in planing. Machine shop: Lateral adduction (and abduction) in use of hand bellows in the lever forge, slight in valve grinding, in reaching to draw abrasive substance in place. Engraving: In "dotting," slight adduction-abduction of right shoulder. Rug weaving: Lateral adduction (and abduction) throwing shuttle in use of sweater machine, passing rags through sheds on the Lane loom. Farm: Using scythe. Gymnasium: Indian clubs, dumb bells, punching bag, medicine ball. Miscellaneous: Wigwag signalling. Ward hand crafts.

V. *Hip.*

Rug weaving: Standing before and using the hand lever of the sweater machine. Gymnasium: Gymnastics, volley ball, hand ball. Miscellaneous: Dancing, covering seed with foot.

VI. *Ankle, Toes and Mid-Tarsus.*

Use of all kinds of foot power machines, especially those with velocipede treadles, or specially tipped pedals to throw the foot upon the outer edge.

PRONATION AND SUPINATION, DEFINITION AND ILLUSTRATION.

Pronation is the movement of the *forearm* in turning the palm of the hand down, to the rear in the erect position.

Supination is the movement of the *forearm* in turning the palm up, to the front in the erect position.

EXAMPLES, SHOPS:

Carpentry: Using screw driver with the screw horizontal, using turning tools, such as gimlet, awl. Machine shop: Use of screw driver and reamer, grinding valves. Engraving: Slight in working on large unmounted plate making curves, in "wriggling," pronation-supination of wrist-elbow, not of wide amplitude, but requiring regular steady movement. May be done quickly or slowly. Rug weaving: Separating alternate threads of the warp of the Gobelin tapestry loom, tying knots in Oriental rug making, throwing shuttle (slight), pulling rag through in hooked rug. Jewelry: polishing and finishing jewelry by hand (jewelry being held in the other hand), in pulling and twisting wires filing concave surfaces, in the finishing process with polishing powder. Modeling: Using horizontal movements. Gymnasium: Gymnastics, boxing, bag punching, various ball games, tennis, tether ball. Farming: Spading, troweling.

CIRCUMDUCTION, DEFINITION AND ILLUSTRATION.

Circumduction is a circular swinging movement as in twirling the *thumbs* or *fingers*, revolving the *wrist* or *ankle*, moving the

shoulder as in the full arm swing, or swing the leg and hip. (A combination of flexion, abduction adduction.)

EXAMPLES, SHOPS:

I. *Thumb.*

Shops: Work on the Gobelin tapestry loom. Turning small carrier wheel on lathe.

II. *Fingers.*

Jewelry: Movement of fingers and thumb in polishing and burnishing.

III. *Wrist.*

Machine shop: Valve grinding with special valve grinding tools. Jewelry: Twisting wire around a mandril to make links, wiring jewelry for soldering, in grinding of enamel in mortar and pestle. Ward hand crafts: Especially rake knitting and basketry.

IV. *Shoulder.* (Adduction, rare.)

Machine shop: Turning cranks with large handles. Rug weaving: Use of sweater machine. Drafting: Sketching in large free hand drawing, movements as in cartooning. Gymnasium: Gymnastics, tennis, volley ball, hand ball, boxing, bag punching. Farm: Use of fork, scythe and shovel. Blackboard writing.

V. *Hip.*

Gymnastics, ball games, soccer, foot ball, dancing.

VI. *Ankle.*

Use of special foot levers, games and dancing.

ROTATION, DEFINITION AND ILLUSTRATION.

Rotation is turning or twisting around an axis as in twisting the *shoulder* in turning a door knob with the elbow and wrist relatively rigid, twisting the *neck*, or the *hip* in moving the toes outward or inward with the knee and ankle relatively rigid. Rotation is sometimes not distinguished from circumduction.

Note: Rotation involved in practically all the occupational activities in which circumduction is present.

General Note: In the majority of tools in the machine shop, strong gripping is required. In the process of jig sawing, die and tool making, a delicate touch is applied.

Oxy-acetylene welding, involves practically all movements of fingers, wrist, elbow and slight movements of shoulder in lowered position. Back, hip, knee, ankle, toes and mid-tarsus movements are involved only in standing and moving around. Lever forge, includes extension-flexion of elbow, extension-flexion of back, adduction and abduction of shoulder.

In rug weaving, there are involved practically all movements of the thumb, fingers, wrist and elbow, with slight shoulder movements in the making of the Oriental rugs.

Examples taken from jewelry are from the finer bench work. Larger and stronger movements would be taken up in a shop equipped with gas are, hip, knee, ankle, mid-tarsus and toe movements would be involved in doing all the larger work, especially with the foot bellows, foot rheostat and enameling furnace.

In modeling, are brought in all of the movements of thumb, fingers, wrist and elbow in a non-intensive form, the amount of exertion varying according to the size and heaviness of the material. Movements of shoulder come in very slightly in moderate sized work, but but these can be extended in margin or increased in strength by the size and heaviness of the work. Back, hip, knee and ankle movements are incidental only, except in large figures where it is necessary to stand and move about in the work.

In farm and automobile work, there are involved practically all movements of all parts of the body. In these two departments, it is more difficult to assign the patient to a limited and special movement, but in the course of time, the desired movement is bound to recur, and the desired exercise is eventually obtained.

The general nature of these, both from the orthopedic and the mental point of view, must be considered in making the assignment, whether to the more monotonous and specific curative work, or to the more general type.

VII. A Preliminary Type Study of Joint Movements involved in Planing on Long Board, Jack Plane.

(Right-handed Worker. See Plate 40, Page 43.)

HAND. The fingers of the right hand, which grasps the handle of the plane, are all flexed and rigid; little movement in these fingers. The amount of flexion may be changed by varying the size of the knob. A few workers grasp the handle of the plane in a way which involves the extending of the index finger and the thumb. The fingers of the left hand, which aids in guiding the plane, are all flexed, but the amount may be modified by changing the size of the knob.

WRIST. One of the most conspicuous movements of the wrist is the abduction in the right wrist—the amplitude and intensity of the abduction varying with the length of the path of the plane, i. e., with the length of the board planed or with the type of plane used; there is also a slight extension of the right wrist. There is an abduction and an extension of the left wrist, but of less degree than in the right.

ELBOW. The right elbow is very active, its movements consisting of extension-flexion, with a slight supination. The movements of the left elbow are primarily extension-flexion.

SHOULDER. Both shoulders are actively involved in planing; the movements are extension-flexion, adduction and a slight rotation—these movements being of greater amplitude and intensity in the right shoulder than in the left.

BACK. There is a marked extension-flexion of the back which is particularly conspicuous in the lumbar region and the shoulder region. These movements are more extended when the path of the plane is long, as in planing a board four feet or more in length.

HIPS. A slight extension-flexion in both hips, increasing in amplitude with the increase in length of the board planed.

KNEE. Extension-flexion in the left knee, little or none in the right.

FEET AND ANKLES. Marked extension-flexion in left ankle, especially when the board is long; relatively slight in right. Extension-flexion in ball of left foot; slight extension-flexion in ball of right foot when path is short, very great when path is long.

In planing a very short board—six inches or less—the movements may be confined to the arms. When the board is lengthened to two feet, the shoulders and back are more involved in the movements. And when the board is lengthened to three feet or upwards, intensive movements of the legs and feet are involved. These movements may vary with the characteristic types of motor coordinations of different individuals and the type of planes used.

Preliminary Type Study of Joint Movements Involved in Engraving. (Right Hand).

(Study made from one subject, engraver by trade.)

1. *In Making Curves.*

A. Right.

1. Fingers. (In holding tool). Flexion of all joints.
2. Thumb. Extension of interphalangeal and meta-carpo-phalangeal joints; used in guiding tool.
3. Wrist, elbow, shoulder rigid. Slightly abducted position of shoulder.

B. Left.

1. In working on large unmounted plate.

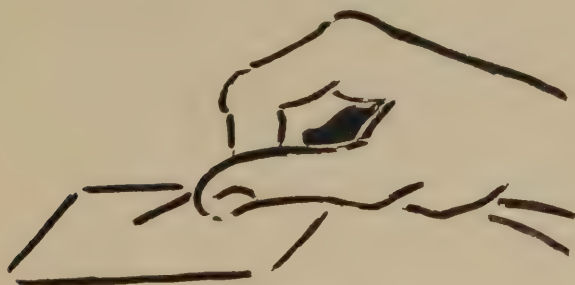


Plate 44

Sketch showing position of thumb and fingers of right hand in holding tool in engraving.

- a. Fingers. Extension of all joints of all fingers; abduction of fingers.
 - b. Thumb. Abducted.
 - c. Wrist. Flexed position, with abduction in turning plate, and adduction in returning to initial position; steady, slow, controlled movement.
 - d. Elbow. Slight extension-flexion; slight pronation-supination.**
 - e. Shoulder. Abduction slight in extent but with a good deal of strength demanded, if the elbow is held away from the table and the movement controlled from the shoulder. (See right hand worker in cut.)**
2. In using wooden block with mounted plate. (See cut).
 - a. Fingers. b. Thumb. Flexion of metacarpo-phalangeal joints; extension of inter-phalangeal joints of fingers and thumb, the amount of extension depending upon the size of the block used, small blocks requiring flexion of all joints.
 - c. Wrist. Flexion in turning block, extension in returning to initial position.
 - d. As above. (No pronation-supination.) (B. I. d.)
 - e. As above. (B. I. e.)
 3. In using regular graver's block.
 - a. Fingers. Flexion of all fingers and thumb.
 - b. As above. (B. I. b.)
 - d. As above. (B. I. d.)
 - e. As above. (B. I. a.)
- II. In "Wriggling."
- A. Right.
 1. Fingers. Flexion in holding tool.



Plate 45

Sketch showing extension of fingers and thumb and flexion and abduction of wrist of left hand in engraving. See section VII. B, I, a, b, c.

2. Thumb. Extension of interphalangeal and metacarpo-phalangeal joint, adducted position of thumb in guiding tool.
3. Wrist-Elbow. Pronation-supination, not of wide amplitude, but requiring regular steady movement. May be done quickly or slowly.
4. Shoulder. Position of slight abduction.
B. As above, in use of the three types of holder.

III. *Dotting.*

A. Right.

1. fingers and thumb. Flexion in firm grasp of tool.
2. Wrist. Slight flexion-extension; adduction-abduction.
3. Elbow. Slight extension-flexion.
4. Shoulder. Slight abduction-adduction; movement quick, snappy, but not as strong as in other movements.

*Example of adaptation to disability by making shorter curves with wrist movement only, and elbow and forearm resting on table.

VIII. Peripheral Nerve Palsies

CAUTION—The principles of curative therapy, as outlined for stiff joints are not applicable to peripheral nerve palsies without distinct modifications, since in all palsy the muscles are paralysed and can be over-stretched easily by wrong exercise. The over-stretching of a paralysed muscle invariably results in irreparable damage. Care should be taken that all cases taking curative therapy wear splints, so constructed as to prevent over-stretching of muscles, but no splint can be made strong enough absolutely to prevent extreme force from causing damage. In nerve lesions only the gentler forms of exercise should be used, and all heavy work avoided.

A few general types of occupational activities to be used in peripheral nerve palsies, may be cited here:

MUSCLES.

1. *Muscle-Spiral.*
Typewriting, typesetting, rug-weaving, piano-playing, adding machine, mechanical drafting.
2. *Ulnar.*
Flexion of metacarpophalangeal joints of all fingers, extension of the two inter-phalangeal joints.
Scroll saw, etc. (with metacarpophalangeal joints safeguarded by splint).
Carving, engraving, etc., which gives gripping of light tools.
3. *Median.*
Flexion of thumb and index finger, with care not to over-stretch. Grasping of light tools in light jewelry, basketry, etc.
4. *Sciatic.*
No specific curative work. Avoid active treadle work and long standing.

5. *External popliteal (foot drop).*

Foot treadle work, safeguarded by right angle stop splint.

Pvt. W. C. E.—*Fingers, Wrist and Elbow.*

Diagnosis: G. S. W. (a) Amputation arm, right middle lower third. Healed. (b) Elbow left limited motion. (c) Forearm left, fractured ulna, involving musculo-spiral and ulna nerves.

Prescription: Flexion—extension of thumb, fingers, elbow.

Assignment: To rug weaving. The left arm was confined in a lock-up splint which made the tying of the knots in the actual rug weaving impossible. He was therefore given the spooling of yarn upon a machine where the heavy work was in the treadle and the hand was used only for starting the wheel and guiding the thread.

Progress: At first, he could not hold the thread, which was therefore passed around a large spool which he could grasp and use for guiding. The holding and releasing of this gave flexion-extension of the fingers and the movements backward and forward in guiding the winding on the large spindle gave flexion-extension of the elbow. In addition to the regular curative exercise which he did for one-half hour each day, he spent two or three hours a day in the shops reading and studying rugs, as he intends to take up the business as a salesman. The arrangement of the splint made it impossible to take accurate measurements of his improvement, but he was able, after two or three weeks, to use his hand sufficiently to hold his fork; and whereas, when he began the work, he could not bend the elbow enough to get the hand less than six inches below the chin, he was able at the later time to get his hand to his head.

IX a.—A Partial List of Selected Tools of Special Curative Value, Arranged in Order of Joints Concerned

The aim is to use standard tools and machinery and to fit special appliances necessary to obtain the desired movement. The size of the handles of all hand tools may be readily changed by the use of ordinary dental modelling composition. Each type of case presents a new or modified problem.

I. *Fingers and Thumb.*

a. Ward Occupations Department.

Clippers, pliers, scissors, eyelet punch, leather tools, typewriter, carving tools, rake, knitting needles, braid mat frame, bead loom, belt loom, Persian rug loom, tapestry loom, braid loom, crotchet hook.

b. Oriental Rug and Textile Department.

Hand looms, combs of various sizes and shapes; needles, long, short, straight and curved; paddles and sheds fitted with handles of different sizes and shapes, spherical, oblate, spade, curved, twisted; tapestry looms, sweater machines.

c. Engraving Department.

Gravers with handles ranging in diameter from seven-eighths of an inch to one and a half inches; engraving blocks ranging from one inch to three inches in length; practice plates involving a span of the worker's hand ranging from one inch to five inches; hand vises; compasses and dividers, handles enlarged and fitted to hand by use of dental modelling composition.

d. Jewelry and Metal Work Department.

Hammers and mallets of various sizes and weights, with handles whose diameters range from one half inch to one and a quarter inches; pliers and tweezers of various forms ranging in span from one-eighth of an inch to two and one quarter inches; chasing tools, hand vises; snips; burnishing tools.

e. Mechanical and Electrical Department.

Hand wrenches of various sizes, shapes and weights, (four to twelve inches in length, eight to thirteen ounces in weight) bolts and nuts of a wide variety of size; cold chisels of various sizes; hammers from eight to thirteen ounces in weight; screw drivers; auto jacks; vises; soldering irons; tap wrenches, pliers and nippers, electric wiring tools.

f. Woodworking Department.

Hammers of various weights and with handles of various sizes ranging in diameter from three-quarters of an inch to two inches; chisels with handles varying from three-quarters of an inch in diameter to two inches and a half; mallets of different weights; screw drivers of various sizes; carving tools of numerous sizes and forms; saws; planes; oil stones; draw knives, special knobs and grips for planes, made by enlarging regular handles by use of dental modelling composition, compasses; gauges and vises.

II. *Wrist and Elbow.*

Most of the tools and appliances already listed under the several departments involve movements which are not limited to the hand and fingers, but also involve movements of the wrist, elbow and other joints of the body. The present list attempts to mention under each heading only those tools and appliances which are most appropriate for curative work with each joint under our main heading.

a. Ward Occupation Work.

Cardboard cutter; colonial mat frame; sock machine; sand paper; rug hook; harness needles; wonder weaver loom; block print tools.

b. Oriental Rug and Textile Department.

Reeds provided with hinged, swinging and frictional devices for push and pull; sheds adapted for various corrective motions; paddles, combs; spinning wheel and distaff equipped with various special appliances, looms, winding machines.

c. Engraving Department.

Gravers tools, hand vises, oil stones, compasses and dividers.

d. Jewelry and Metal Work Department.

Hammers and mallets, chasing tools, hand vises, pliers, tweezers, snips, scissors, files, burnishing tools, soldering outfit, oil stone.

e. Mechanical and Electrical Department.

Wrenches; hammers, files, vise, breast drill, auto jack, hack saw, auto chassis; hand auto pump, soldering outfit, tap wrenches, machine tools with handles, hack saws, sensitive drill, hand shears, punching machine.

f. Wood Working Department.

Hammers, saws, planes, drawing knife, hatchet, brads awl, spoke shave, screwdriver, brace and bit, hand drill, whetstone, saws, plane, carving tools, chisels, compasses and dividers, hand emery wheels, mitre box, wood clamps and metal clamps, gauge, vises, wood turning lathes, mallets, sand paper, rasps, hand power post drill presses.

III. *Shoulder.*

a. Ward Occupational Department.

Clothes wringer, block printing, saw, cardboard cutter, wonder weaver loom, braid loom, Sloyd knife, colonial mat frame, carving tools.

b. Oriental Rug and Textile Department.

Paddles, reeds, sheds, looms, spinning wheel, distaff.

c. Engraving Department.

Gravers, engraving blocks, oil stones, dividers and compasses.

d. Jewelry and Metal Work Department.

Hammers and mallets, hack saw, files, chasing tools, burnishing tools, vises, pliers, tweezers, snips, soldering outfit, burnishing tools.

e. Mechanical and Electrical Department.

Wrenches, hammers, files, hack saws, breast drills, auto jacks, hand auto pumps, vises, tap wrenches, belt shippers, hand drill, electric wiring, hand-blown forge.

f. Woodworking Department.

Hammers, saws, planes, drawing knives, hatchets, screw drivers, brad awls, chisels, wood carving tools, brace and bit, hand drills, hand emery wheels, clamps, vises, rasps, sand paper, vertical hand drilling machines, for crank and lever motion.

IV. *Back.*

b. Oriental Rug and Textile Department.

Looms, spinning wheels, distaff.

e. Mechanical and Electrical Department.

Hand auto pump.

f. Wood Working Department.

Planes, draw knife, with shaving bench, brace and bit, saws, sand paper.

V. *Hips.*

b. Oriental Rug and Textile Department.

Treadle looms, spinning wheel, distaff, winding machines, sweater machines.

e. Mechanical and Electrical Department.

Auto jacks, hand auto pumps, lifting machines and materials.

f. Wood Working Department.

Planes, saws, shaving benches, treadle lathes, with varying strokes, treadle grindstones, jig saws and scroll saws, planer.

VI. *Knee.*

- a. Ward Occupation Department.

Treadle looms, jig saws.

- b. Oriental Rug and Textile Department.

Treadle looms, treadle spool winding, sewing machines.

- e. Mechanical and Electrical Department.

Auto Jack; foot power lathes.

- f. Wood Working Department.

Planes (long boards) shaving benches, foot lathes of varying strokes, jig saws, scroll saws, grindstones, foot mortising machines.

VII. *Ankle, Mid-Tarsus and Toes.*

- a. Ward Occupation Department.

Treadle looms, jig saws.

- b. Oriental Rug and Textile Department.

Treadle loom, spinning wheel, distaff, sewing machines.

- e. Mechanical and Electrical Department.

Auto Jack, foot power lathes.

- f. Wood Working Department.

Foot lathes of varying strokes, shaving benches, grindstones with adjustable connecting rods, (foot power) jig saws, scroll saws, foot mortising machines, power mortising machines.

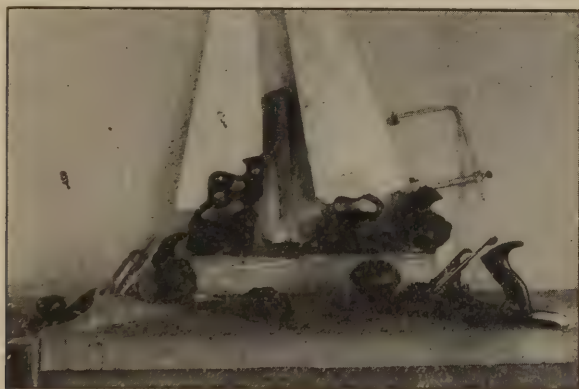


Plate 46

Specially adapted handles made from dental modeling wax.



Plate 47

Specially adapted foot power machines for exercise of ankle, knee or hip.



Plate 48

A project representing varied light movements made by patient with disabled right hand and forearm.

X Type. Cases

Pvt. C. B.

I. *Personal and Educational History.*

Supply Company 166. Age 26. Eighth grade. Left at the age of 16 years. Unskilled laborer. Cabinet making. Brakeman on railroad. Future occupation, railroad inspector. Personal history, good. No venereal disease. Enlisted May 30, 1917.

II. *History of Disability.*

July 17, 1918, while in action on Lorraine front was hit by rifle bullet in left hand.

July 17. Evac. Hosp. No. 2. Operation debridement of wound. Suture tendon sheaths. Removal of spiculae bone. August 1, fingers partially flexed. August 3, surface wound healing, unable to flex ring and little finger of left hand. Unable to extend middle and index finger. August 10, surface wound healed. Unable to use fingers. Pyroderma developed, condition of fingers not improved. Pyroderma improved August 25. August 30, Base No. 6. Surface wound healed with limitation of movement of hand. September 22, Base No. 8. Hand still in splint, though wound is healed.

Condition on admission to this hospital: Left hand healed at base of all fingers on outer surface. Fingers cannot be made to form a fist and are stiff.

Diagnosis: Healed gunshot wound, left hand, palmar surface with little contraction.

Massage, hydro-therapy and exercise daily.

X-Ray report: O-Fracture, proximal end of proximal phalanges of 2, 3, 4, 5 fingers.

October 29. Union is present with deformity of 2, 4, 5 proximal phalanges.

November 20. Finger shows some improvement, but stiff.

December 1. Since admission finger has improved. Present treatment continued.

III. *Occupational Therapy.*

Prescription for work in curative shops for flexion of fingers sent in October 24th. Assigned the same day to carpentry, where his first project was edge planing and sawing in making a file box, the handling of tools requiring flexion and extension of the fingers. At his own request, he was also assigned to one hour a day of type-writing as supplementary curative exercise. In this work there is finger extension and flexion, the exercise fostering dexterity rather than the strength given by the carpentry. An hour massage daily completed the curative program. His attitude throughout has been one of keen interest in his improvement. At first specially adapted tools were used in the carpentry to increase the flexion and extension of the fingers. In the planing work, the patient used difficult with the left hand. An enlarged hammer handle with finger-ferent sized knobs, ranging from $1\frac{1}{4}$ to $3\frac{1}{2}$ inches, holding the knobs

strapped made it possible for him to grip the hammer firmly and do the nailing with the left hand. These special devices were soon dropped, and the saw, hammer, mallet and chisel of ordinary sizes were used in the making of a large filing cabinet. The week before Christmas, toy airplanes and a set of doll's furniture which he made required the handling of finer tools. All of his spare time was spent in the woodshop. In typewriting, he was gaining in strength and endurance in the use of his left hand. He could reach every key with proper fingering, and one day worked 90 minutes without tiring. In addition to this he has done curative work in his ward. The measurements of voluntary movements taken in the psychological laboratory from November 27 to December 19 show a gain in range of flexion-extension in degrees as follows:

	3rd Joint (Distal)	2nd Joint (Interphalangeal)	1st Joint (Metacarpophalangeal)
II Finger.....	18.0	22.4	15.6
III Finger.....	24.5	25.8	7.3
IV Finger.....	3.2	29.3	7.3
V Finger.....	6.4	5.0	2.7

The third joints of the fourth and fifth fingers were still incapable of complete extension when the patient was transferred to a convalescent camp.

Pvt. J. S., Co. B, 166th Inf.

I. Personal and Educational History.

Third grade school, completed schooling at 10 years of age.

Main occupation, farming.

Future occupation, farming.

II. History of Disability.

July 21, 1918, while fighting at Chateau Thierry, wounded by high explosive on forearm. Admitted to dressing station, then to Field Hospital No. 4, then to No. 7. Then to Paris, then to Vichy, then to New York. General health good. Field Hospital No. 168. Compound fracture left elbow, gunshot wound penetrating left elbow. Base Hospital, F. C. C. Ulnar left on junction of lower middle third. Field 168, July 28. Redressing. Gunshot wound multiple, large wound on left forearm inner side. C. C. F. left ulnar three inches above wrist. Debridement Base 19. Gunshot wound, possible fracture. August 13. X-Ray. Base 155. F. C. C. Junction lower and middle thirds. U. S. A. Debarkation on Ellis Island. Arrived October 2 for No. 2, Staten Island. Departed October 21 for Walter Reed. Admitted October 21.

Nov. 3. Massage, hydro-therapy, exercise daily.

X-Ray. Fracture through lower and middle third of ulnar. Small metallic fragment is present. Bones of wrist show considerable lime and salt absorption.

III. *Occupational Therapy.*

Diagnosis, Oct. 24: Gunshot wound, left elbow and forearm. Compound fracture ulna. Unhealed. Slight limitation motion. Sent to the curative workshops for flexion-extension of thumb, finger, wrist, elbow, with the caution that over use of elbow was to be avoided. He was assigned to the rug weaving department, where the tying of the Turkish knot would involve finger and wrist movements, with the avoidance of strong elbow movements. He was also assigned to typewriting at his own request, and because in this he would gain dexterity of finger movement. He was from the first, regular in his attendance at his daily appointment and soon asked for an extra hour in the afternoon. Shortly after this, he asked that he be allowed to drop the typewriting in order to devote all his time to the rug work, which he believed was the best exercise for his hand, and in which he had become so much interested that he was considering taking it up as a vocation. He completed one small rug made with the Turkish knot and has begun his second with the more intricate Persian knot, while the healing of the wound made it possible for him to bring in the elbow motion which he had formerly avoided. Worked constantly until the time of his transfer to convalescent camp on Jan. 9, 1919. Measurements of the range of voluntary extension-flexion of the finger joints showed improvement, typified by the figures for the distal joint of his fourth finger, given in Table Case III.

Private S. F., Co. C, 7th Inf.

I. *Personal and Educational History.*

Twenty-six years of age.

Seven grades. Left at the age of 17 years.

Main occupation, farming and tool factory.

Future occupation, probably will return to farm. General health, good.

II. *History of Disability.*

In action in Chateau Thierry, received shrapnel wound right forearm and right lower chest wall. July 14, 1918. Admitted July 16, American Red Cross Hospital, France. Gun shot wound, multiple, right side. General wounds right, with gun shot wound right fore arm. Gas gangrene chest and fore arm. Radio artery cut. X-Ray negative. July 26, Base No. 6, multiple perforating wound right upper forearm. Daykns tubes in situ. Possible nerve injury, weakness of right wrist and hand. Some numbness. Right side of chest wall, dirty, lacerating, granulating wound. Aug. 1. Operation. Base No. 114. Aug. 24. Wounds practically healed. Requires massage. Sept. 11, all wounds healed. Dropped splint to hold forearm. Base No. 8, Sept. 28. All wounds healed. Wrist drop, right forearm stiff and patient unable to supinate it. Oct. 9, left for port of embarkation. Base No. 8. Sept. 28. Arrived Walter Reed Hospital Oct. 24.

Diagnosis: Wound on chest healed, elbow motion good. Supination of forearm normal. Three healed scars on outer and inner aspects, upper third right forearm. Can make fist and fully extend fingers. Gun shot wound, multiple, penetrating right forearm.

X-Ray report: No signs of any injury to bones of forearm. Bones of wrist show some salt absorption.

III. *Occupational Therapy.*

On November 2, patient was assigned to curative shops for flexion-extension of thumb, fingers and wrist. An hour's work each day was to be taken in the jewelry shop for curative purposes, while the afternoon was to be spent at the farm where the vocational would be united with the curative. In the metal work, he was given the pulling of copper wire which requires strength and flexion in the fingers, and extension in the releasing and changing of the tool. In the hammering out of rings from French coins, elbow extension-flexion was acquired. At first, work was changed every fifteen minutes to avoid fatigue. As his grip improved, he was able to handle the small saw, and in sawing out a silver ring with open work pattern and his initial in it, he gained in flexion of fingers by grasping the handle, in wrist extension-flexion and elbow extension. The filing required holding very small tools and in this it was at first necessary to utilize the left hand as aid. The patient asked to be allowed to give up the farm work, as he felt that the metal work was more curative and that all his time should be devoted to it. He now spends afternoon as well as morning at the shop. Measurements of the voluntary movements taken in the laboratory have given to the patient from day to day the actual figures of his improvement. For example, in one month he gained 44.2 per cent in the movement of the third joint of the 4th finger over the initial measurement. (See Case IV Table.)

XI. **Supplementary Comments.**

The preceding section of this Monograph indicates the procedure in the treatment of stiffened joints, followed in the Curative Shops in the Walter Reed General Hospital. The method has been worked out inductively to meet situations as they arose; but the system as presented here offers a program attained in many, but does not include all cases. Physical and mental reconstruction work is a new feature in Army Hospital organization, and this Monograph is issued for our convenience and to assist others who are attempting work in a similar field. It is therefore advisable to state the difficulties and obstacles which have been encountered. These can be classified into two general groups—one of a psychological nature and the other, administrative.

The psychological difficulty lies mainly in the mental attitude of the patients, and a consequent reluctance of many to begin occupa-

tional therapeutic work. The basis of this obstacle depends mainly on the following conditions:

1. Frequently, there is a misunderstanding as to the real object of the work. To some patients it presents merely a means to keep occupied, and unless they can see the direct vocational bearing and curative value, they are unwilling to undertake this work. The interviewing and assigning officers must see that the patients fully realize the significance of the work for curative purposes which forms as important a part of modern therapeutic treatment, as medicine, massage or electro-therapy.

2. Many patients believe that the Reconstruction Work will lengthen their stay at the Hospital, and it is the desire of all to get home as soon as possible—especially since the signing of the Armistice. Some patients have expressed the belief that as long as they were found to be improving, they might be detained until this improvement was completed, while if they were given up as hopeless cases, they might be discharged or transferred at once, and the compensation would be greater than if they were cured. These ideas, though often not expressed openly, are frequently at the basis of their reluctance, and must be recognized, met, and dispelled, where possible.

3. The patients in many instances are in a fatigued condition from their experiences in France. This physical disability is augmented by a constant shifting from hospital to hospital, from ward to ward, and in meeting the new situations, both military and social. Patients have not yet attained their mental alertness and normal health.

4. Patients also find it difficult after becoming accustomed to hospital and army life, to regain their point of view of civil life, in which initiative, self-interest and self-responsibility are such important factors. Often when asked what they expect to do after leaving the army, the men are nonplussed at the situation facing them. This attitude is enhanced by the relief associations and the attitude of misdirected sympathy on the part of the public, which may become the disabled man's worst enemy.

In other cases, work undertaken for its curative value only, has been continued from a vocational interest and the man has been placed in the same kind of work as a trade, on leaving the hospital.

Administrative—A limited number of unavoidable administrative conditions in this hospital have interfered with the practice and the carrying out of the occupational program. These may be summarized as follows:

1. The proximity of the hospital to the city of Washington presents a difficult problem, since the outside interests continually encroach upon the time of the men, which might be given to Reconstruction work. The men are constantly invited to the city, and the pleasures from the city come to the hospital. These interests undoubtedly have value, but are exceedingly difficult to control and standardize.

2. The distance of the Reconstruction Shops from the wards, and the great distances to be covered in the hospital grounds, afford difficulties, especially in rainy weather, for leg amputation cases, of which we have a large number.

3. Theoretically, the surgeon sends the man to the shop immediately on his arrival at the hospital, but in many instances, this does not occur for days, weeks, and in some cases, months afterward. The work has been on a voluntary basis, and occasionally men do not report although repeatedly notified by the nurse, surgeon or a representative of the Reconstruction Department. The work is now being made compulsory, where possible. For the past five months we have had from 1,000 to 1,300 patients enrolled monthly in the work.

4. The occupational work is subsidiary to the regular hospital routine and must give way to ward inspection, medical attendance, transfer from ward to ward, furloughs, passes and other types of medical and other administrative regulations.

5. The hospital having been largely a training school, the shifting nature of the staff has caused certain courses to be dropped or modified, after the patient has started the work. This has been particularly true in the physical training department, and has been beyond the control of the hospital.

6. Following the signing of the armistice, the morale on the part of the instructors has been lowered, since all are anxious to return to civilian life, and this has reflected on the patients, although it is remarkable how well both the patients and men have overcome the inanitions accompanying this great morale readjustment which has been going on throughout the country at large. At present, March, 1919, the morale is greatly improved.

XII Appendix

Outline of Psychological Service

It has been found that the psychologist can be of direct service to the medical officer and the educational instructor:

1. By giving to each the results of a personal, social and intellectual survey of the disabled man in the form of a synoptic picture of his mental capacity, his special aptitudes, his temperament and his ability to learn.

2. By analyzing, evaluating and directing the mental attitude of the patient toward himself, his wound, his future and toward others, and, also by directing the attitude of others toward him, by helping to develop a good morale in the hospital.

3. By helping the patient to find himself, helping him to see what others have done and what he can do, and by helping him to act again as a whole man physically, socially, and vocationally. By adapting the work to medical or surgical needs of the patient.

4. By working with amputation cases in co-operation with the

surgeon, the officer in charge of artificial limbs and the teacher on the *learning problem* of using the remaining member for fundamental movements, the artificial member for auxiliary movements, the transfer of former finer movements to the remaining member.

5. By the study of methods of teaching employed in the curative workshop schedule with a view to suggesting improvements.

6. By co-operating with the psychiatrist in the study of mental deficiency and the study of nervous cases.

The psychological work in the hospital has been organized with the aim of enabling the patient to act again as a normal man, physically, socially, vocationally and economically. The following lines of work are being carried out:

I. *Surveys to obtain information regarding the patient's*

- a. Personal, social, educational and vocational history.
- b. Special interests, aptitudes and abilities.

II. *Examinations to determine intellectual capacities and analyze mental abnormalities.*

- a. Group and individual examinations of general intelligence to be used as additional evidence of patient's fitness for a given curative occupational assignment or for permanent vocational training.

1. Alpha examination for high grade literates.

2. Stanford-Binet and Point Scale examinations for low grade literates.

3. Army performance test for illiterates.

- b. Individual psychological examination for patients exhibiting special mental abilities or disabilities.

1. Examinations requested by the neuro-psychiatrists to aid in diagnosis and disposition of their patients.

2. Examinations of psychiatric cases who cannot be interviewed and assigned to curative work through the usual methods owing to their special defects and susceptibilities. Assignment of such cases either to ward gardens, to shops, typewriting, etc., follows directly upon examination.

3. Investigation of psychological causes of special cases of maladjustment, with counsel to patient and general recommendation.

III. *Examinations to determine skill in the various occupations, by means of trade tests.*

- a. In order that the patient may be assigned to curative work which may at the same time furnish vocational training, whenever such is possible.
- b. For the Information of the Federal Board for Vocational Education.

IV. *Measurements of Voluntary Movement and Muscular Strength.*

a. Procedure:

1. Measurement in degrees of the range of voluntary movements of various joints in isolation.
2. Measurement in pounds of the strength of muscles governing the various movements in upper and lower extremities.

b. Purpose:

1. To obtain necessary information for proper assignment to curative work,
 - a. Adapted to limited powers of the patient.
 - a. As required for sufficient exercise to develop increased function of the partially disabled limb.
2. To obtain in numerical and graphical form, reports which may be used:
 - a. To encourage and stimulate the patient to persist in the prescribed curative work by showing him definitely the progress of improvement.
 - b. To furnish to the surgeon definite information as to the patient's progress.
 - c. To keep the instructor informed as to the patient's progress that he may adapt the work to changing needs.

V. *Work on the learning problem with a view to determining and applying the most effective methods of teaching:*

- a. In developing greater use of the remaining or uninjured limb by transferring its functions to the other.
- b. In training for effective use of the artificial limb, or a partially disabled limb.
- c. In applying psycho-educational measurements.

VI. *Development of Morale:*

- a. By inducing a proper mental attitude on the part of the patient in regard to his disability and his future by—
 1. Showing him what others similarly handicapped have done.
 2. Showing him that the hospital treatment is really producing beneficial results.
 3. By making clear what steps the government has taken to provide for his future in the way of compensation, insurance and vocational re-habilitation.
- b. By providing opportunities for the patient's recreation and amusement while in the hospital:
 1. Through the agencies of the Red Cross, Y. M. C. A., K. of C. and J. W. B.
 2. Through use of the gymnasium for athletics, dancing, etc.

3. Through educational excursions to Mt. Vernon, Capitol, etc.

Need of further psychological work along the lines specified below is clearly indicated by:

1. An extension of work on the learning problem:
 - a. To apply the most effective methods of teaching in academic work.
2. Measurements of sensitivity in cases of injured nerves, or sutured nerves.
3. Measurements of speed and accuracy of movement and motor co-ordination.



